Truck of the Future: A Public-Private Partnership Pilot

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14. ABSTRACT
The Truck of the Future (ToF) pilot program is a public-private road safety initiative developed by Together for Safer Roads (TSR) and its members. The ToF pilot aimed to examine and better understand the feasibility of implementing a vulnerable road user (VRU) detection system across both public and private sector fleets to enhance drivers' visibility of people walking or riding a motorcycle, moped, bicycle, scooter, skateboard, or other personal conveyance, who can be hidden in the blind zones of large vehicles. Results from the pilot suggest that the novel VRU detection system encouraged drivers to reduce severe speeding. In one fleet, the proportion of VRU alerts triggered while the driver was speeding decreased from 23% to 17% after the in-cab alerts were turned on, suggesting that VRU detection alerts may have benefits beyond improving visibility of VRUs. Both drivers and managers using the VRU detection system provided positive feedback on the system and rated the alerts as useful when driving. The completion of the ToF pilot program highlights the viability of a public-private partnership model to quickly introduce, adopt, and iterate novel technologies designed to enhance safety on the road.

15. SUBJECT TERMS
Vulnerable road user, fleet, aftermarket safety device, alerts, public-private partnership, speeding, indirect vision, and safety.

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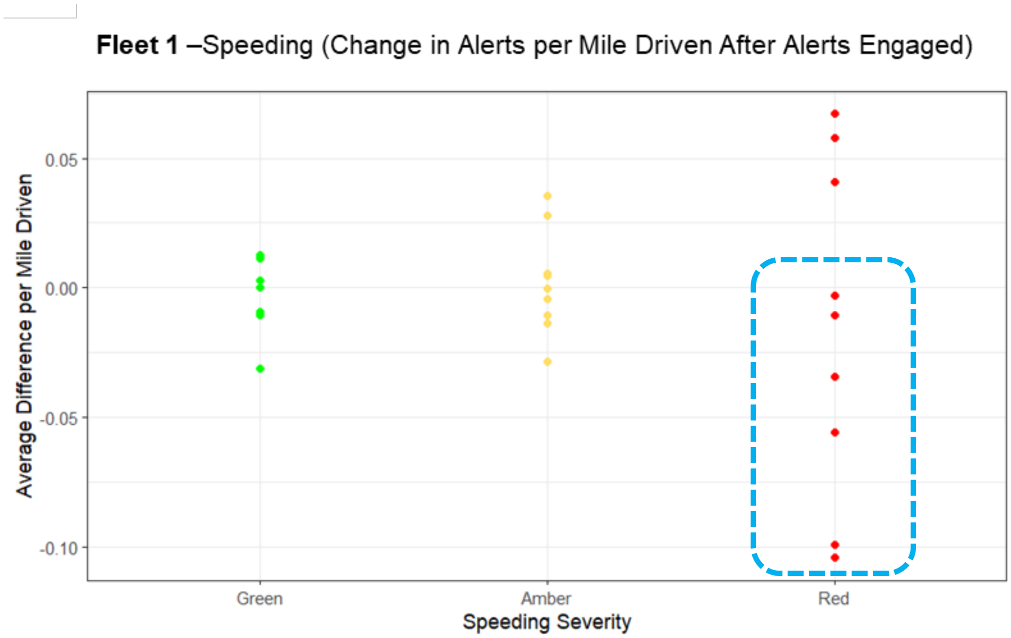
Executive Summary

The Truck of the Future (ToF) pilot program is a public-private road safety initiative developed by Together for Safer Roads (TSR) and its members. Pilot participants included the City of New York and AB InBev. VisionTrack was the technology supplier. The ToF pilot aimed to examine and better understand the feasibility of implementing a vulnerable road user (VRU) detection system across both public and private sector fleets to enhance drivers' visibility of people walking or riding a motorcycle, moped, bicycle, scooter, skateboard, or other personal conveyance, who can be hidden in the blind zones of large vehicles. The initiative also supports NYC Mayoral Executive Order 39 of 2024 which aims to address visual obstructions for truck operators from the City fleet and contractors.

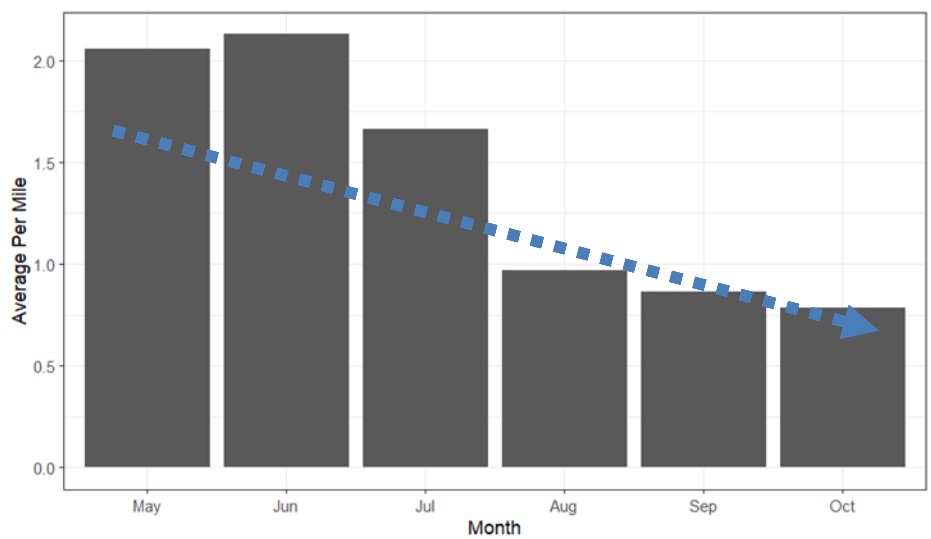
The system, developed by VisionTrack and based on machine vision cameras and audiovisual alerts powered by AI technology, consists of both driver-facing and VRU-facing aftermarket devices mounted on each vehicle. It was deployed on a total of 30 fleet vehicles across two City of New York fleets from NYC Department of Environmental Protection (DEP) and NYC Parks (referred to as Fleet 1 and Fleet 2), and AB InBev's subsidiary in Mexico City. Data were collected from March to October 2023 timeframe, and a user experience and implementation survey of drivers and managers was administered. Volpe analyzed these data to develop the analysis in this report. Key analysis findings include:

- In the driver and fleet manager survey responses (n = 28), both types of respondents generally provided positive feedback on the system and rated the system as useful.
- When examining the effects of the VRU detection system on Fleet 1, severe speeding decreased for 6 out of the 9 drivers that participated in the program. Further, the proportion of VRU alerts triggered while the driver was speeding decreased from 23% to 17% after the in-cab alerts were turned on. This finding was surprising since the system did not alert drivers when they are speeding. The apparent reduction in severe speeding by Fleet 1 vehicles suggests the VRU detection alerts may have secondary benefits that warrant further study.



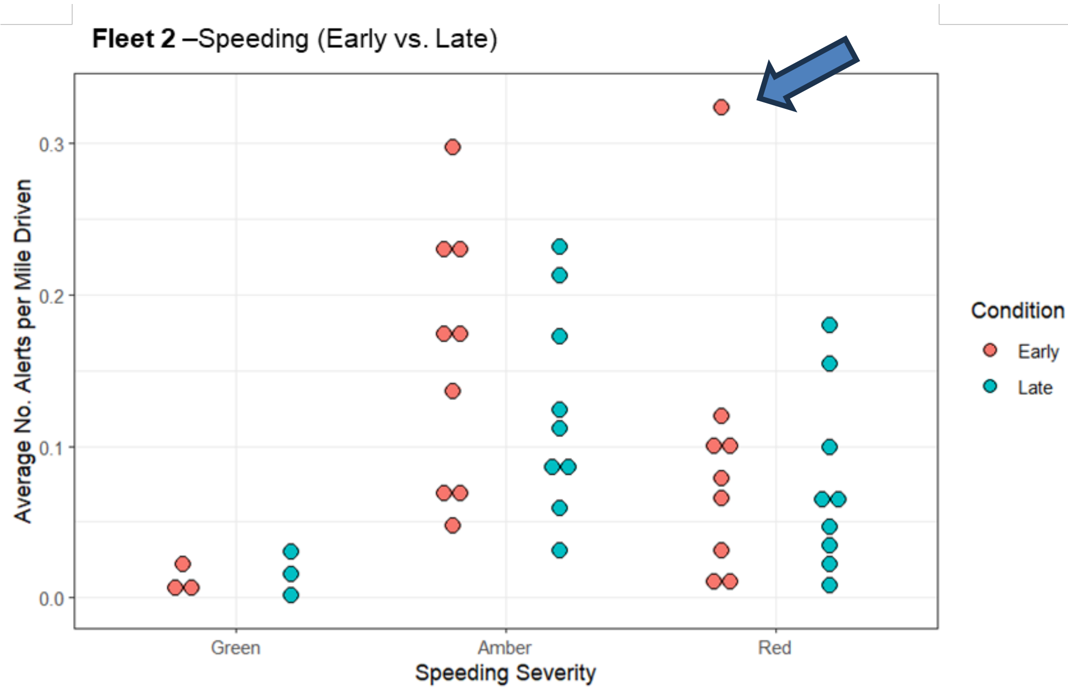
- The AB InBev fleet saw approximately 50% reduction in the number of VRU alerts over the first three months of the pilot before plateauing. Although this may demonstrate changes in driver behavior or that the external auditory alerts discouraged VRUs from approaching the vehicles, it is also possible that extrinsic factors (such as seasons, weather, school schedule, etc.) contributed to the reduction in alerts between May and October, as this decrease was not clearly seen in the other fleets.

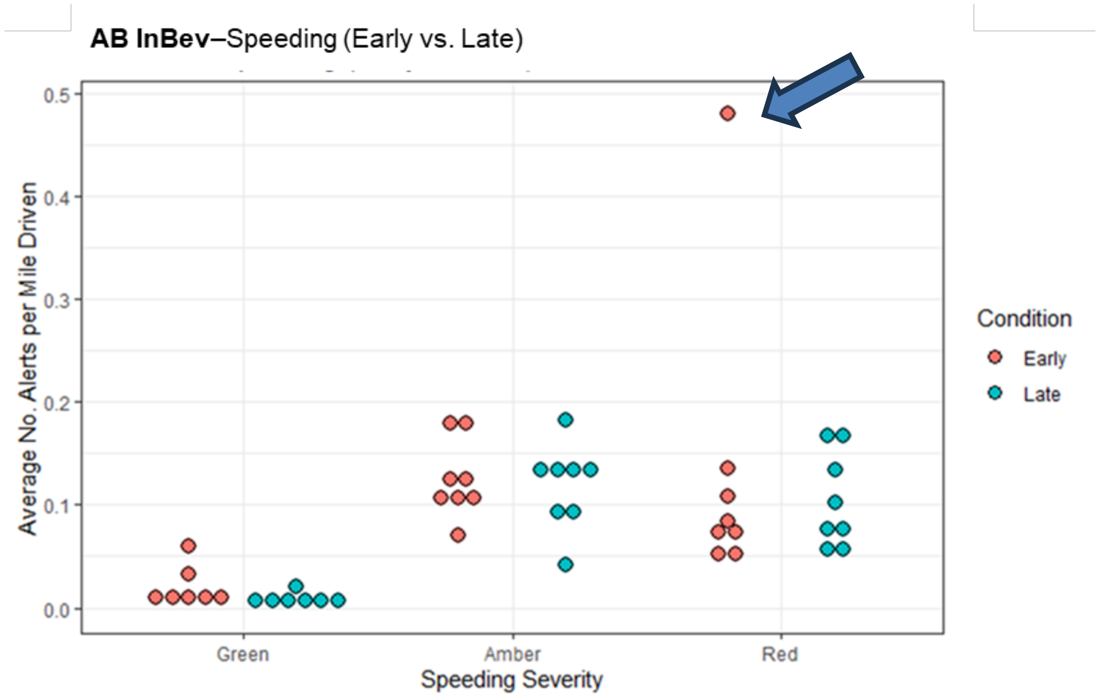
AB InBev–Average VRU Alerts per Mile Driven by Month



- In both Fleet 2 and the AB InBev fleet, it appears that an outlier speeder reduced the number of speeding alerts per mile driven between the start and end of the pilot. This was somewhat unexpected, as the drivers were not directly alerted when they went over the speed limit.

Fleet 2 –Speeding (Early vs. Late)





Data collection with the NYC pilot for Fleet 1 is ongoing, and this additional data may clarify longer-term benefits and trends. Future pilots could incorporate detection systems with other safety features such as intelligent speed assistance (ISA), making speed reduction a primary rather than potential secondary intended effect. Lower speeds can reduce both the risk and the severity of crashes, especially with VRUs.

1. Introduction

1.1 Overview of ToF pilot

In 2021, 84% of the 7,388 pedestrian fatalities recorded in the United States occurred in urban areas, demonstrating the urgent need to implement countermeasures to keep pedestrians and other vulnerable road users (VRUs) safe.[1] Nationally, NHTSA data shows that the number of frontover fatalities – instances where a driver hits and kills someone directly in front of them – has almost doubled in the past five years from 284 fatalities in 2015 to 526 frontover fatalities (and over 10,000 injuries) in 2020.[2] A 2006 University of Michigan study found that 20 percent of truck-initiated crashes are linked to poor visibility from the driver's seat.[3] Simply put, driver skill cannot overcome what the driver cannot see, and drivers of large vehicles have limited visibility around them when they are behind the wheel.

The *Truck of the Future* (ToF) pilot program is a public-private partnership to demonstrate how certain aftermarket technologies can be combined and implemented to potentially reduce instances of near misses of large vehicles in urban areas with Vulnerable Road Users (VRUs) –a person either walking or riding a motorcycle, moped, bicycle, scooter, skateboard, or other personal conveyance. For the pilot program, a VRU Detection System was installed on fleet vehicles, designed to improve driver safety as well as the safety of pedestrians, cyclists, and motorcyclists, by using camera technology to give a 360-degree view of vision around the vehicle and provide real-time feedback on near-misses. In the context of this pilot study, a "near miss" is any instance when a VRU comes within 0.8 meters of the fleet vehicle, thus triggering the VRU Detection System.

The pilot also set out to demonstrate the viability of a public-private partnership model whereby new technology is rapidly introduced, adopted, and iterated upon within the context of a discrete project to create quicker, actionable change in a real-world environment. As part of this, the process was intentional in its broad-based stakeholder engagement model, e.g., ensuring that drivers and fleet safety officials were included in the planning, implementation, and modulation of the technology throughout the pilot period.

1.1.1 Pilot Participants

Participants in the Truck of the Future (ToF) include both public and private organizations.

- Together for Safer Roads (TSR; NGO and partnership coordinator)
- City of New York (Public fleet)
  - 20 vehicles from two NYC fleets participated in the pilot: Fleet 1 and Fleet 2.
- AB InBev (Private fleet)

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[1] Insurance Institute for Highway Safety (2023). *Fatality Facts 2021: Pedestrians.* https://www.iihs.org/topics/fatality-statistics/detail/pedestrians

[2] National Highway Traffic Safety Administration (2023*). Non-Traffic Surveillance: Fatality and Injury Statistics in Non-Traffic Crashes, 2016 to 2020 (Revised)*. DOT HS 813 363. https://crashstats.nhtsa.gov/Api/Public/ViewPublication/813363.pdf

[3] Reed, M.P, Blower, D., & Flannagan, M.J. (2006). Prioritizing Improvements to truck driver vision. *University of Michigan Transportation Research Institute*.

    - 10 vehicles from AB InBev's subsidiary in Mexico City participated in the pilot.
- VisionTrack (Technology supplier)

The U.S. DOT Volpe National Transportation Systems Center was asked to serve in an independent advisory and evaluative role and to develop this preliminary analysis and report.

1.1.2 Technology

The technology in the ToF pilot, developed by a technology supplier called VisionTrack, consists of both driver-facing and vulnerable road user (VRU)-facing aftermarket devices mounted on each vehicle and collectively intended to reduce near misses between VRUs and fleet vehicles. The system is designed to detect all VRUs –pedestrians, bicyclists, motorcyclists, and people using scooters. Using artificial intelligence (AI), the system detects and warns drivers of VRUs surrounding the vehicle that may not otherwise be visible. The package of devices include:

- External turning alert (verbal message and light flash)
- Internal audible VRU alert (verbal message)
    - Quad-screen camera display

1.1.3 Purpose and goal

TSR coordinated a pilot deployment of these technologies on public and private large fleet vehicles in two major cities from March 2023 to October 2023. The purpose of the pilot and of the present report is to (1) evaluate the potential of a suite of aftermarket devices to reduce near-misses with vulnerable road users and (2) demonstrate the viability of a public-private partnership model whereby new technology is rapidly introduced, adopted, and iterated upon within the context of a discrete project to create quicker, actionable change in a real-world environment.

2. Methods

2.1 VisionTrack camera system

The VisionTrack camera system consists of four camera views: front, rear, left, and right. A live feed of these camera views is visible to the driver. When a VRU is detected, they are outlined by a red box along with a red triangle with an exclamation point to capture the attention of the driver (Figure 1). The quad-screen view would shift to the single view where the VRU was detected. In addition, an auditory and visual alert is given to notify the driver that a vulnerable road user is close to the truck and their general location. For example, if a VRU was detected on the right side of the driver's truck, a voice alert would state "Alert, pedestrian right".

For the current pilot, only VRUs that were detected within 0.8 meters of the vehicle were flagged to the driver. This ensured that drivers would only be alerted to VRUs in their immediate vicinity, reducing the possibility of alert fatigue.

Figure 1. Image from VisionTrack system (left). Drivers also saw a warning icon when the VRU was detected (right).

In addition to the camera feed and VRU detection, the VisionTrack system also included a telematics device that recorded instances of speeding, location, and harsh maneuvering (e.g., harsh braking and acceleration).

2.2 Telematics software platform

When a VRU was detected by the VisionTrack system, the camera feed and momentary vehicle data (e.g., current speed) was uploaded in real time to an online platform. This allowed managers and administrators to monitor vehicle behavior and how drivers interacted with VRUs.

2.3 Data collection across fleets

Although three fleets participated in the ToF pilot, system implementation and data collection practices varied across fleets.

While the system was simultaneously installed and turned on in the AB InBev and NYC Fleet 2, there was a baseline period with NYC Fleet 1 where VRUs were detected and recorded by the system, but drivers did not receive in-cab alerts. In addition, harsh maneuvering and instances of speeding were also recorded during the baseline period. This allowed Volpe to examine whether the auditory and visual in-cab alerts may have affected driving behavior.

3. Survey results

Surveys were developed by the TSR team and distributed by NYC and AB InBev representatives to both drivers and managers and deployed towards the end of the pilot period. Twenty AB InBev drivers and five AB InBev managers responded to the survey. Three managers from NYC responded to the survey. In addition, drivers in the AB InBev fleet were given a short survey midway through the pilot program on general satisfaction with the system.

Drivers were asked to rate and provide feedback on their experience with a range of topics such as training on in-cab alert system, the perceived usefulness of the alerts, whether the alerts were fatiguing, and ease of installation. Managers were asked about topics such as the usability of the online Vision Track software platform and whether reviewing footage was useful in their role as a manager.

Questions in the survey were a mix of Likert-like scale questions where respondents were asked to rate a feature from 1 (most negative) to 5 (most positive) and open-ended questions where participants could report more detailed feedback or opinions. A subset of the survey questions is reported below.

3.1 Drivers

Overall, AB InBev drivers appeared to have a positive opinion of the alerts provided by the system and the experience of the pilot overall. Of the 10 drivers that responded to a survey given midway through the pilot, nine thought that the alerts would help prevent a crash, with seven stating that the VRU detection system had helped them personally.

Of the 20 drivers who responded to the full survey, 19 respondents stated that they thought the training they received on the system was helpful and sixteen thought they received effective support throughout the program. The average rating for whether the in-cab audio alerts were helpful when driving was 3.00 (*standard deviation [SD]* = 1.17). The in-cab visual alerts were rated slightly higher with an average rating of 3.30 (*SD* = 1.26). Overall, when asked if the cameras and alert systems were helpful at making the roads safer, they gave an average of 3.40 (*SD* = 1.10), indicating that they did find them helpful. Drivers on average rated the alert fatigue level 2.75 (*SD* = 1.25), indicating they viewed the alerts as neither overwhelmingly fatiguing nor not fatiguing. These results are also shown in Table 1.

Open-ended feedback indicated that some drivers would prefer it if the alerts they received were more specific. For example, one driver wrote that they would like it if the alerts could differentiate between motorcycles and pedestrians. This sentiment was echoed by two other drivers that completed the survey.

Table 1. Average driver survey responses

Fleet	N	How helpful are the in-cab AUDIO alerts when you are driving? (1 not helpful - 5 very helpful)	How helpful are the in-cab VISUAL alerts when you are driving? (1 not helpful - 5 very helpful)	Are the in-cab alerts fatiguing? (1 very fatiguing - 5 not fatiguing)	How helpful do you feel the cameras and alert systems are for making roads safer? (not helpful - very helpful)
AB InBev	20	3.00 (*SD* = 1.17)	3.30 (*SD* = 1.26)	2.75 (*SD* = 1.17)	3.40 (*SD* = 1.10)

3.2 Managers

Managers from both NYC and AB InBev overall rated the system and the corresponding platform as useful and easy to use. When rating the intuitiveness of the platform, NYC managers on average rated it as a 4.67 (*SD* = 0.58), with AB InBev managers giving it an average rating of 4.0 (*SD* = 0.00). In addition, the footage obtained was rated as useful by both NYC managers (*M* = 5.00, *SD* =0.00) and AB InBev managers (*M* = 4.25, *SD* = 0.50). In addition, both NYC (*M* = 5.00, *SD* = 0.00) and AB InBev managers (*M* = 4.80, *SD* = 0.45) felt that the cameras and alert systems were very helpful in making the roads safer. When asked the exact same question, management (compared to drivers) rated the cameras and alert systems as being slightly more helpful at making the roads safer. These results are also shown in Table 2.

Table 2. Average manager survey responses

Fleet	N	How intuitive is the software platform to use and navigate? (1 not intuitive - 5 very intuitive)	How useful is the footage in your role as a manager/admin? (1 not useful - 5 very useful)	How helpful do you feel the cameras and alert systems are for making roads safer? (not helpful - very helpful)
NYC	3	4.67 (*SD* = 0.58)	5.00 (*SD* =0.00)	5.00 (SD = 0.00)
AB InBev	5	4.00 (*SD* = 0.00)	4.25 (*SD* = 0.50)	4.80 (*SD* = 0.45)

3.3 Open-ended comment

One narrative comment made by fleet managers was that the placement of the cameras sometimes made them vulnerable to damage. For example, cameras in the rear sometimes came loose and were prone to becoming obscured by dirt. This type of specific, user feedback is critical to these types of pilot programs, creating valuable insights to help future potential participants and fleets better implement the program.

4. Quantitative analysis

The variables Volpe analyzed can be grouped into three categories: VRU detection alerts (from the right, left, front, and rear of the vehicle), harsh maneuvering (acceleration, braking, g-shock, and cornering), and speeding (green, amber, and red severity).

For the speeding data, speeding alerts were categorized by severity:

1. Red: 25% or over the speed limit
2. Amber: 11-24% over the speed limit
3. Green: 10% or less over the speed limit

For Fleet 1, Volpe calculated the difference in average alerts per mile in the pre (before drivers heard the alerts) and post (after the driver heard the alerts). A negative value means that the number of alerts per mile driven went down in the post period. A positive value means that the number of alerts per mile driven went up in the post period.

In addition, for Fleet 1, Volpe mapped out the average number of alerts for the post period only. This was to allow for comparisons across fleets if desired.

For each fleet, Volpe also mapped a comparison between alerts per mile driven in the "early" stages of the pilot (first two weeks) and the "late" stages of the pilot (last two weeks). Only vehicles that had alerts in both time periods were included in these charts. Note that the dates were not consistent across fleets, so there may be some seasonal influences:

- NYC Fleet 1
  - Early: September 18 -October 1, 2023
  - Late: October 18-October 31, 2023
- NYC Fleet 2
  - Early: March 1 -March 14, 2023
  - Late: August 18-August 31, 2023
- AB InBev
  - Early: May 1 -May 14, 2023
  - Late: October 18-October 31, 2023

Although behaviors were mapped for all variables and fleets, only graphs that demonstrate potentially relevant patterns are included below. For a complete list of results by fleet, please see the Appendix.

4.1 Results

As shown in Figure 2, in Fleet 1, turning on the VRU alerts may have led to a reduction in speeding alerts, especially in the most severe "red" category. Six out of the nine vehicles showed a decrease in red alerts. This was somewhat unexpected, as the drivers were not directly alerted when they went over the speed limit.

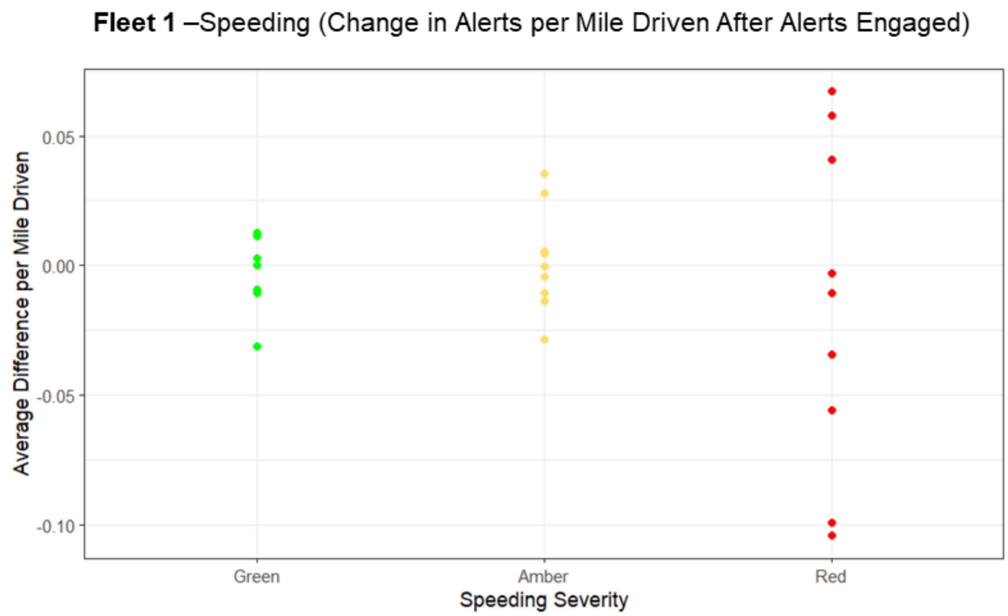

Figure 2. Fleet 1 speeding alerts

To examine this finding further, Volpe examined the relationship between VRU alerts and instances of speeding in Fleet 1. Before the in-cab alerts were engaged, drivers were speeding during 23.13% of 1,267 VRU detections. However, after the in-cab alerts were engaged, that proportion dropped to 17.02% of 2,198 VRU detections.

In Fleet 2 (Figure 3), although there was not an overall reduction in speeding over the course of the pilot, it does appear that outlier speeders came down over time. This was somewhat unexpected, as the drivers were not directly alerted when they went over the speed limit.

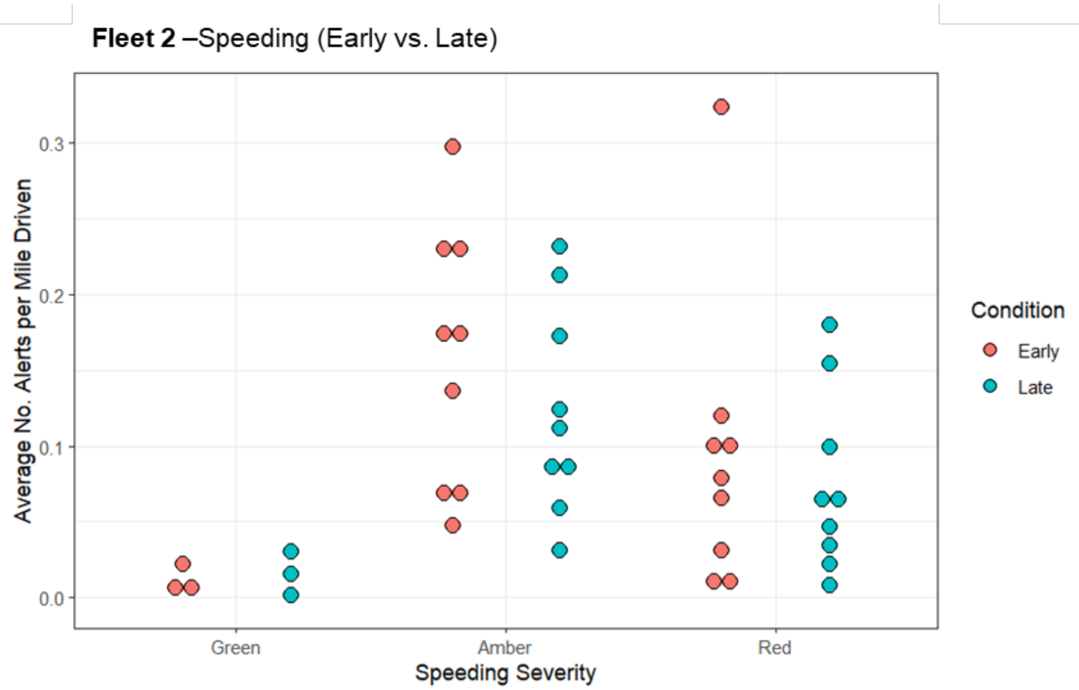

Figure 3. Fleet 2 speeding alerts

When examining the distribution of speeding counts by month, normalized by mile driven, in Fleet 2, it appears that there was a decrease in the number of alerts for the first three months (Figure 4). However, there was a slight increase in the number of alerts towards the last few months of the pilot.

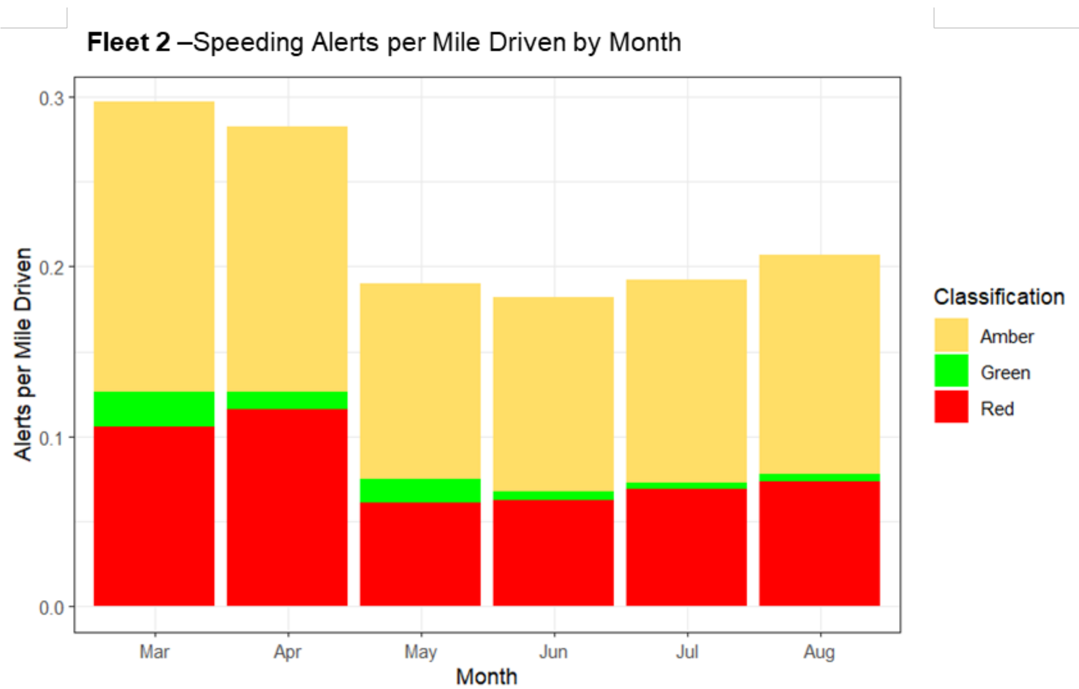

Figure 4. Fleet 2 speeding alerts by month per mile driven

Although there were no discernable patterns in VRU alerts early versus late in the pilot, when mapped on a month-by-month basis, there was an increase in the number of alerts per mile driven during late spring and the summer (Figure 5). One possible reason for this is that as the weather got warmer, more people may have opted to walk or bike, increasing the likelihood that the system would flag a VRU.

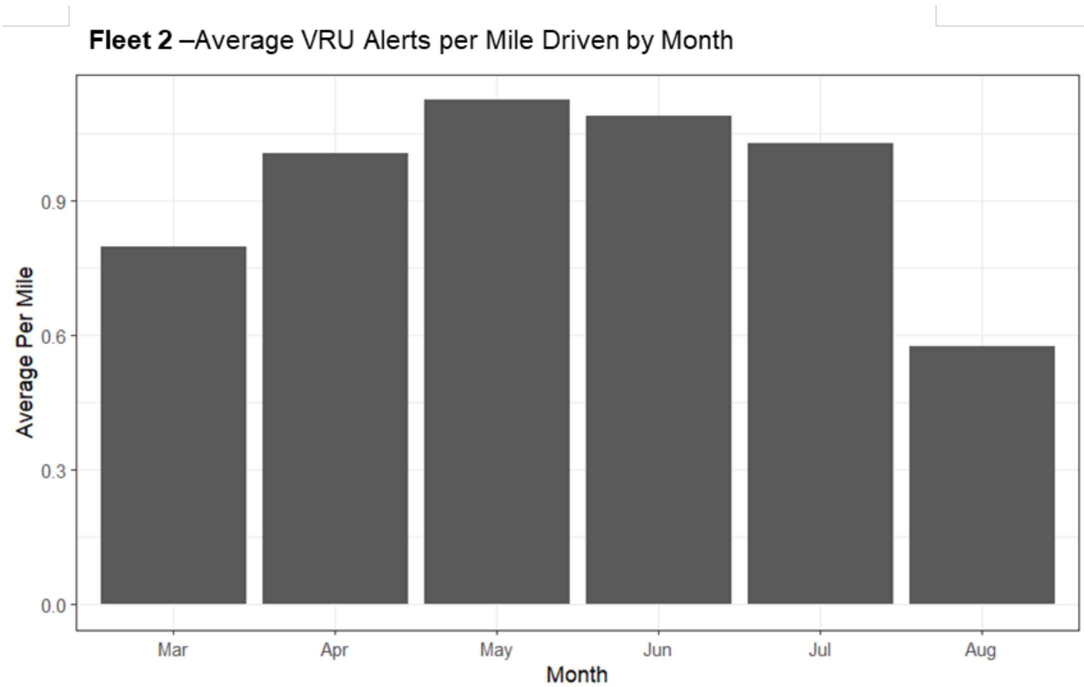

Figure 5. Fleet 2 VRU alerts by month per mile driven

In the AB InBev fleet (Figure 6), it appeared that there was a reduction in the number of VRU alerts from early in the pilot to late in the pilot. Although this may demonstrate changes in driver behavior or that the external auditory alerts discouraged VRUs from approaching the vehicles, we should also consider if environmental factors (such as seasons, weather, or festivals) may have contributed to the reduction in alerts between May and October, especially since this decrease was not clearly seen in the other fleets.

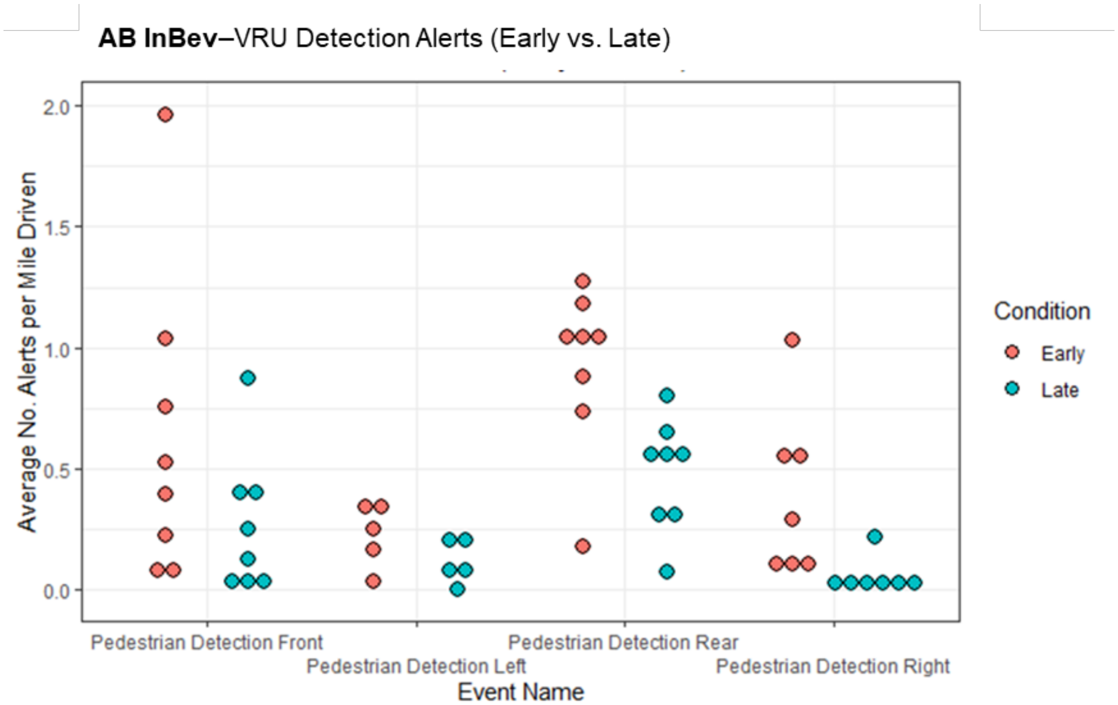

Figure 6. AB InBev VRU detection alerts

When mapped on a monthly basis, the number of VRU alerts per mile driven appeared to have a steady decline in the first three months of the pilot before plateauing (Figure 7).

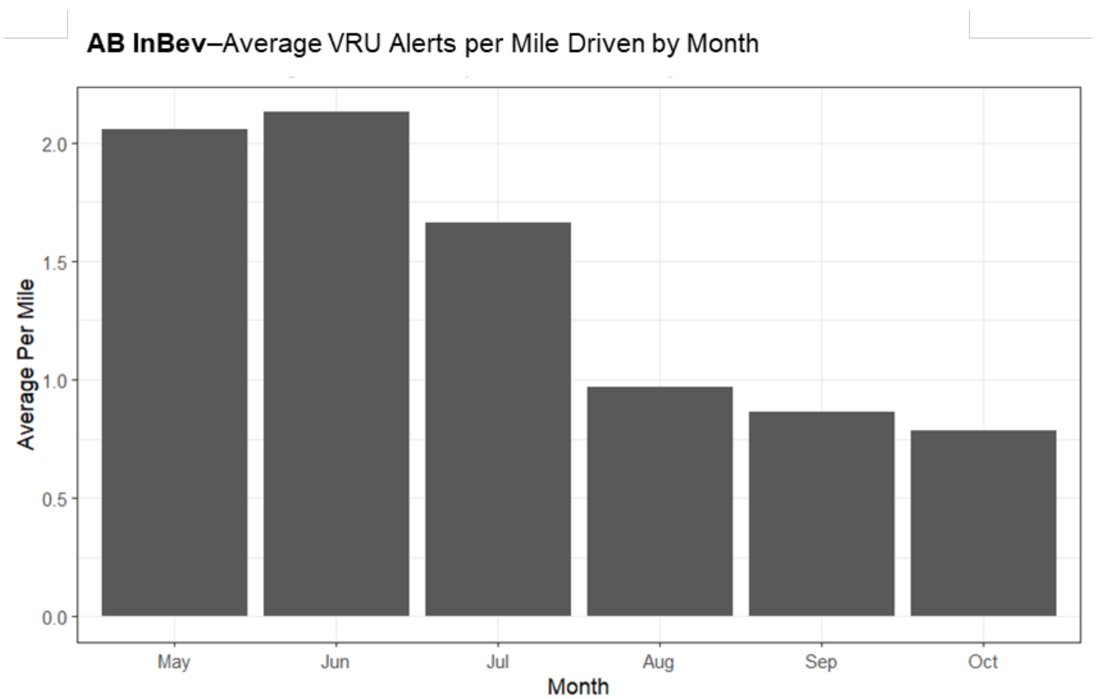

Figure 7. AB InBev VRU alerts by month per mile driven

Again, although there was no general reduction in speeding alerts per mile driven between the first and last two weeks of the pilot in the AB InBev fleet (Figure 8), it does seem like an outlier speeder reduced the number of times they sped at a level 25% or more over the speed limit.

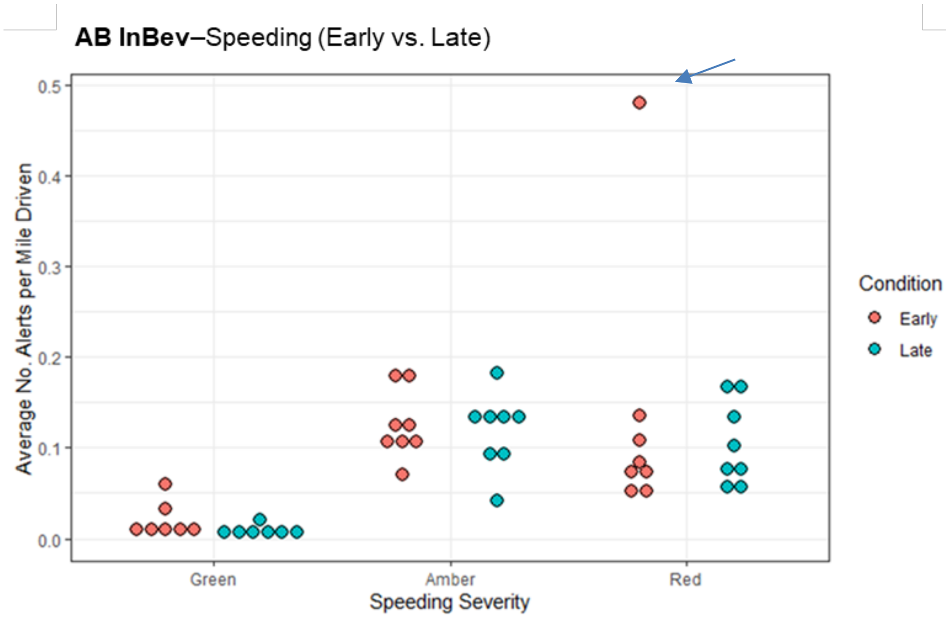

Figure 8. AB InBev speeding alerts

Whereas the number of VRU alerts per mile driven went down over time in the AB InBev fleet, the number of speeding alerts appeared to increase generally on a month-by-month basis (Figure 9). Although not directly interpretable, paired with the monthly pattern of VRU alerts, it may be possible that a reduction in VRUs (or potentially other traffic) afforded the fleet drivers more opportunities to speed.

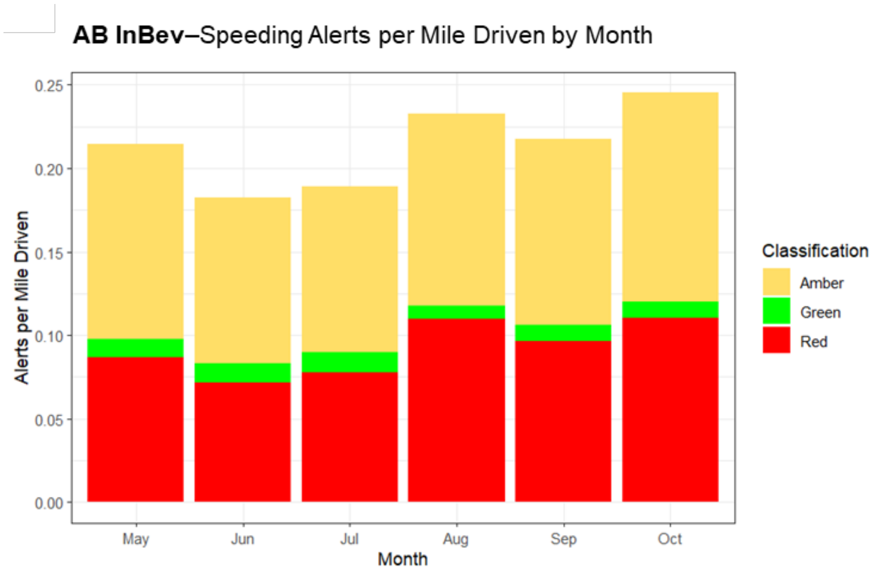

Figure 9. AB InBev speeding alerts by month per mile driven

5. Discussion and Future Directions

The ToF pilot aimed to examine the feasibility of implementing a VRU detection system to enhance drivers' visibility of other road users. In survey responses, both managers and drivers provided overall positive feedback on the system, rating the system as useful.

When examining the effects of the VRU detection system on Fleet 1, severe speeding decreased for 6 out of the 9 drivers that participated in the program. This may suggest either that drivers opted to slow down in areas where VRUs were likely to be present and detected or that drivers opted to simply speed less in general after the alerts were engaged. Further, the proportion of VRU alerts triggered while the driver was speeding decreased from 23% to 17% after the in-cab alerts were turned on. This finding was surprising as the system does not directly alert drivers when they are speeding. The reduction in severe speeding suggests that the VRU detection system may have benefits beyond providing indirect vision and detection alerts.

In the AB InBev fleet, it appeared that there was an approximately 50% reduction in the number of VRU alerts over the first three months of the pilot before plateauing. Although this may demonstrate changes in driver behavior or that the external auditory alerts discouraged VRUs from approaching the vehicles, it is possible that environmental factors (such as seasons, weather, or festivals) may have contributed to the reduction in alerts between May and October, as this decrease was not clearly seen in the other fleets.

In both Fleet 2 and the AB InBev fleet, it appears that an outlier speeder reduced the number of speeding alerts per mile driven between the start and end of the pilot. This was somewhat unexpected, as the drivers were not directly alerted when they went over the speed limit.

Data collection for the Fleet 1 pilot is ongoing. Additional data may help clarify potential long-term benefits and trends. Given the system's potential secondary effects on speeding behavior, future pilots could consider integrating the detection system with other safety features such as intelligent speed assistance (ISA).

The pilot also set out to demonstrate the viability of a public-private partnership model whereby new technology is rapidly introduced, adopted, and iterated upon within the context of a discrete project to create quicker, actionable change in a real-world environment. This outcome was achieved, as is seen through the collaboration of various public-private partners involved in the pilot to successfully on-board, implement, and test the program among key fleet vehicles in day-to-day operations.

6. Appendix

6.1 NYC Fleet 1 –Difference between pre/post alert engagement

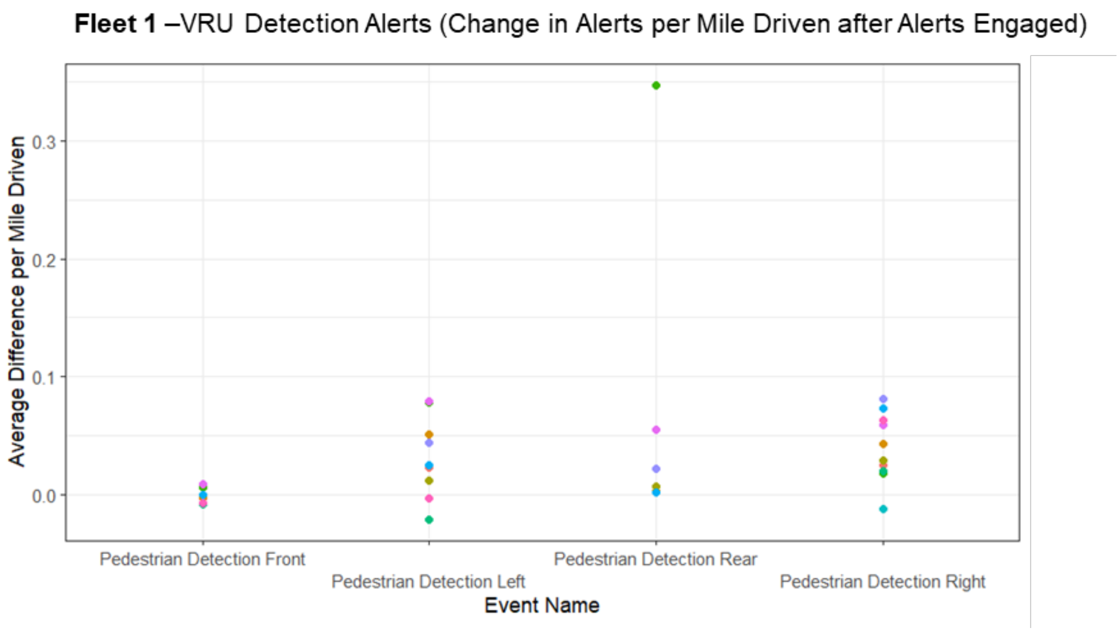

Figure 10. Change in Fleet 1 VRU detection alerts per mile driven, by individual vehicle.

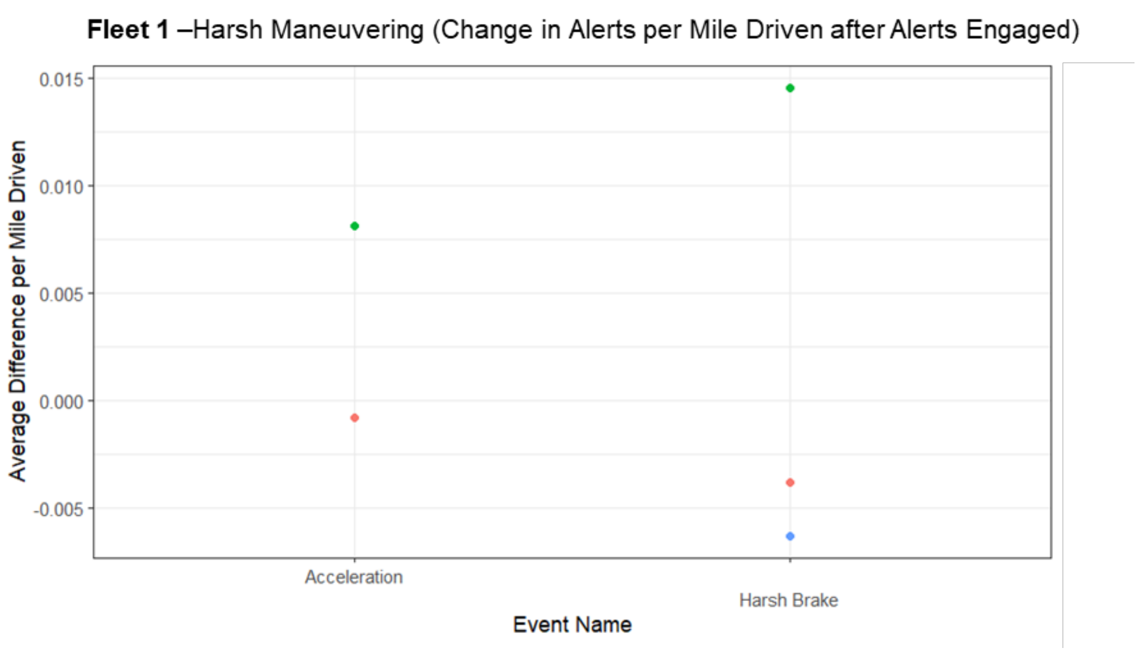

Figure 11. Change in Fleet 1 harsh maneuvering alerts per mile driven, by individual vehicle.

Figure 12. Change in Fleet 1 speeding alerts per mile driven, by individual vehicle.

6.2 NYC Fleet 1 –After alerts were engaged

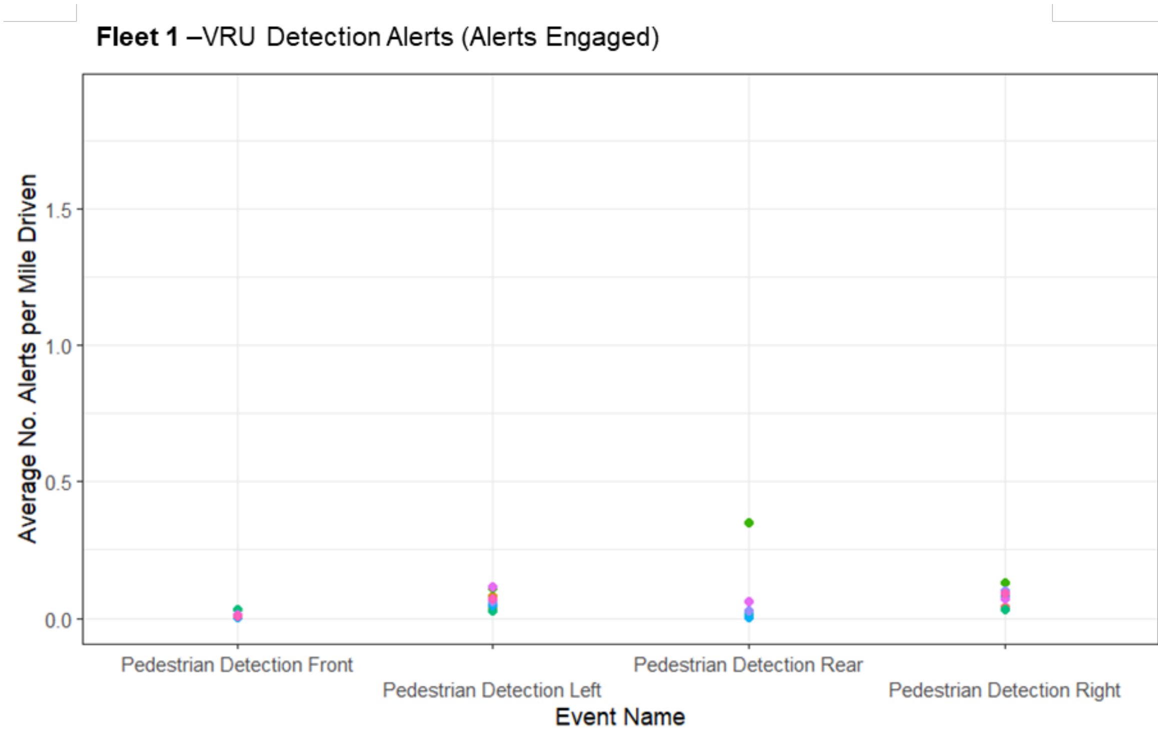

Figure 13. Fleet 1 VRU alerts

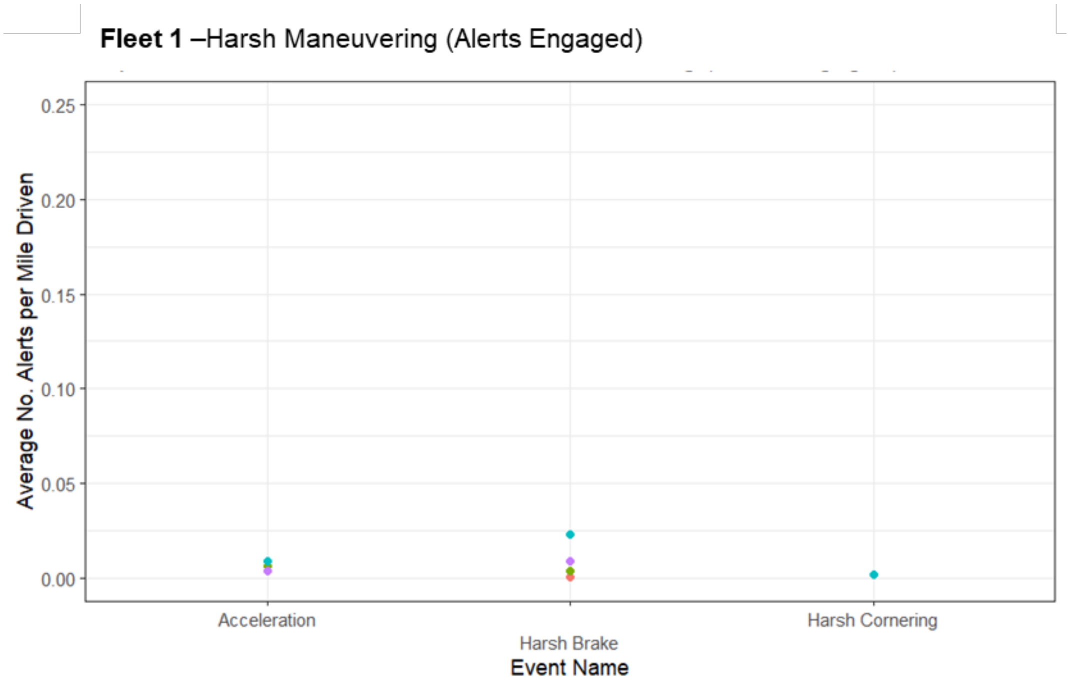

Figure 14. Harsh maneuvering alerts

Figure 15. Speeding alerts

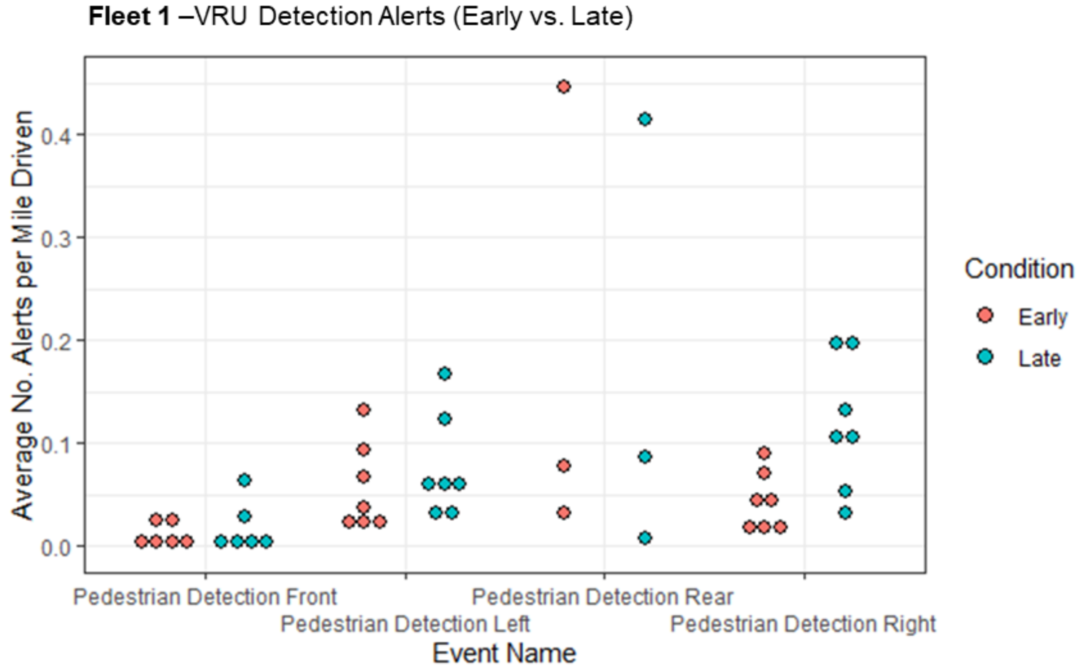

Figure 16. Fleet 1 VRU alerts

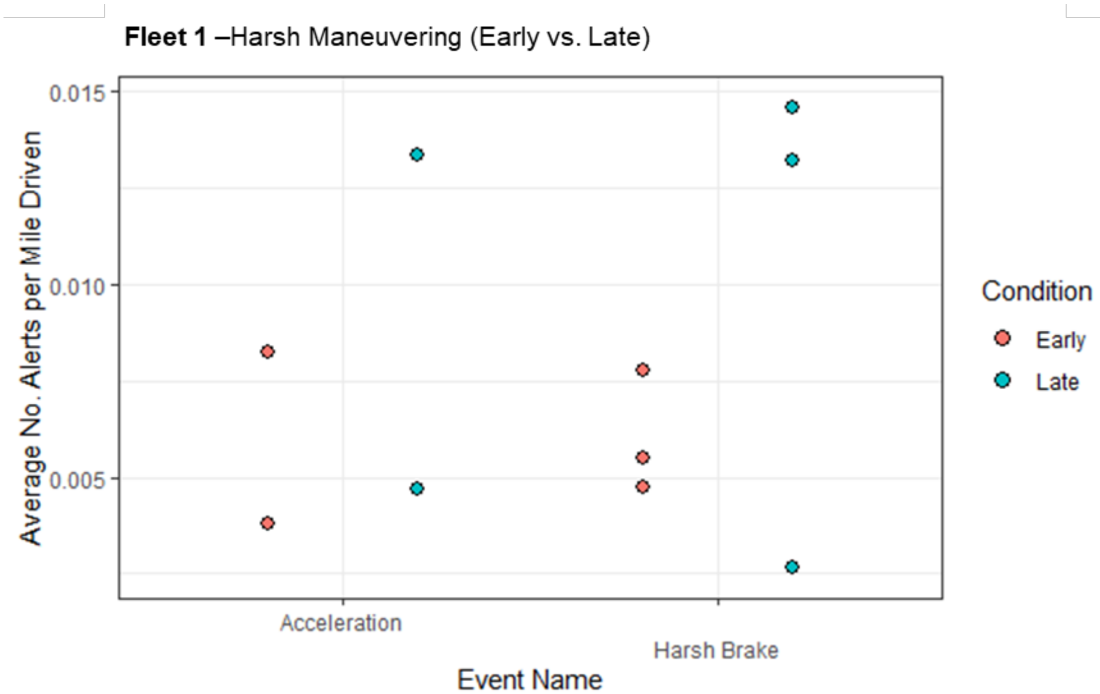

Figure 17. Fleet 1 Harsh maneuvering

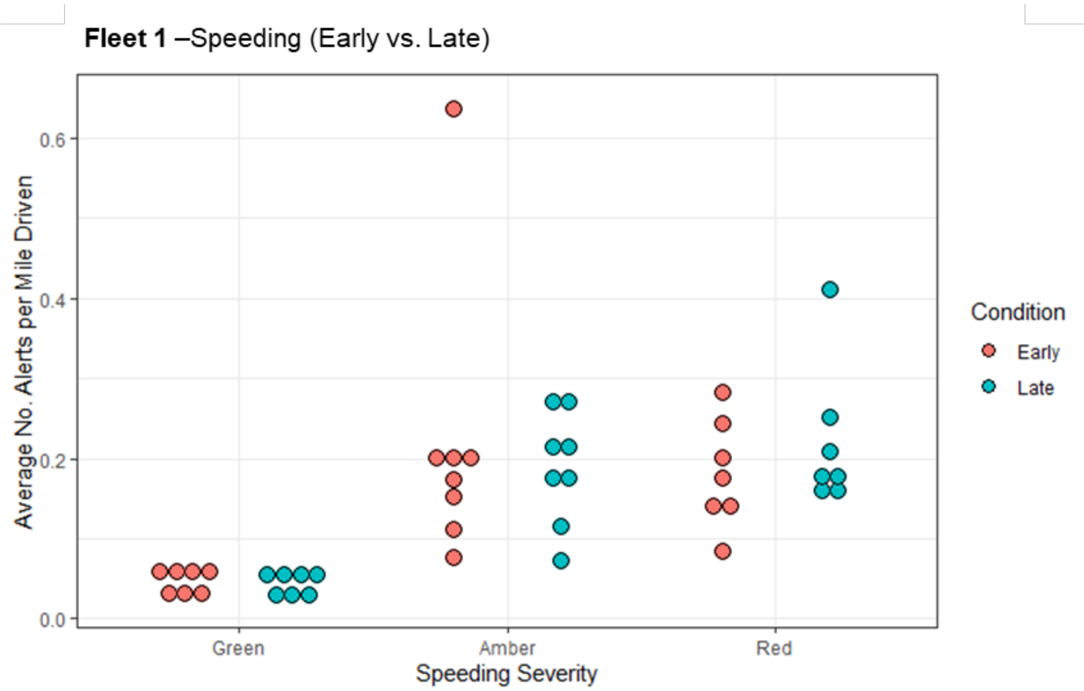

Figure 18. Fleet 1 speeding alerts

6.3 NYC Fleet 2

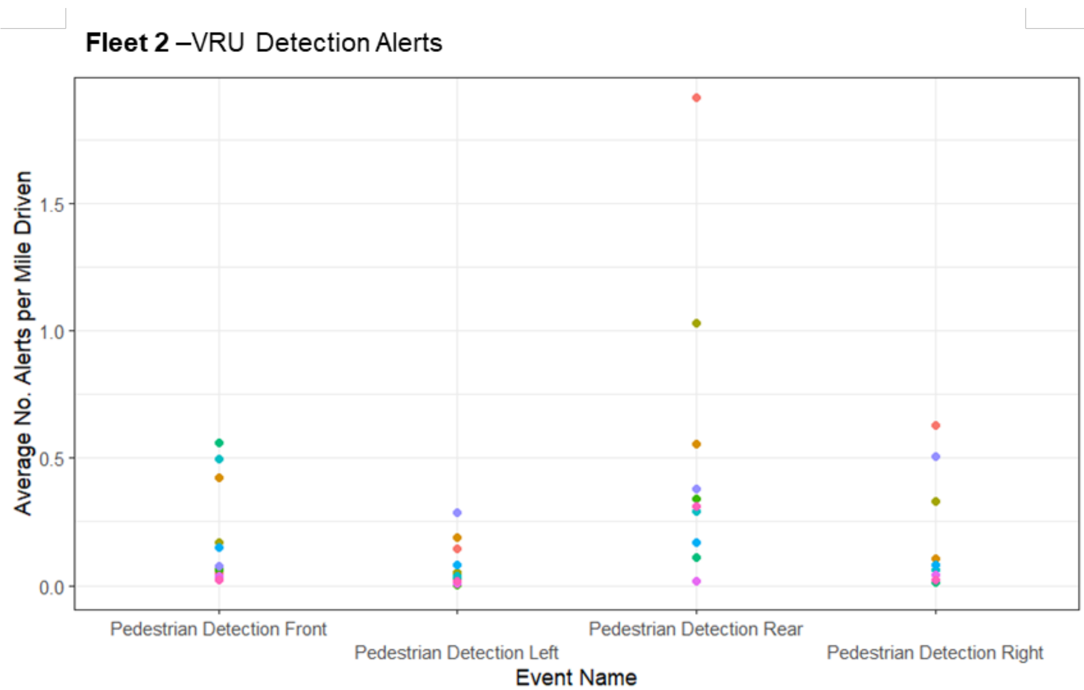

Figure 19. Fleet 2 VRU alerts

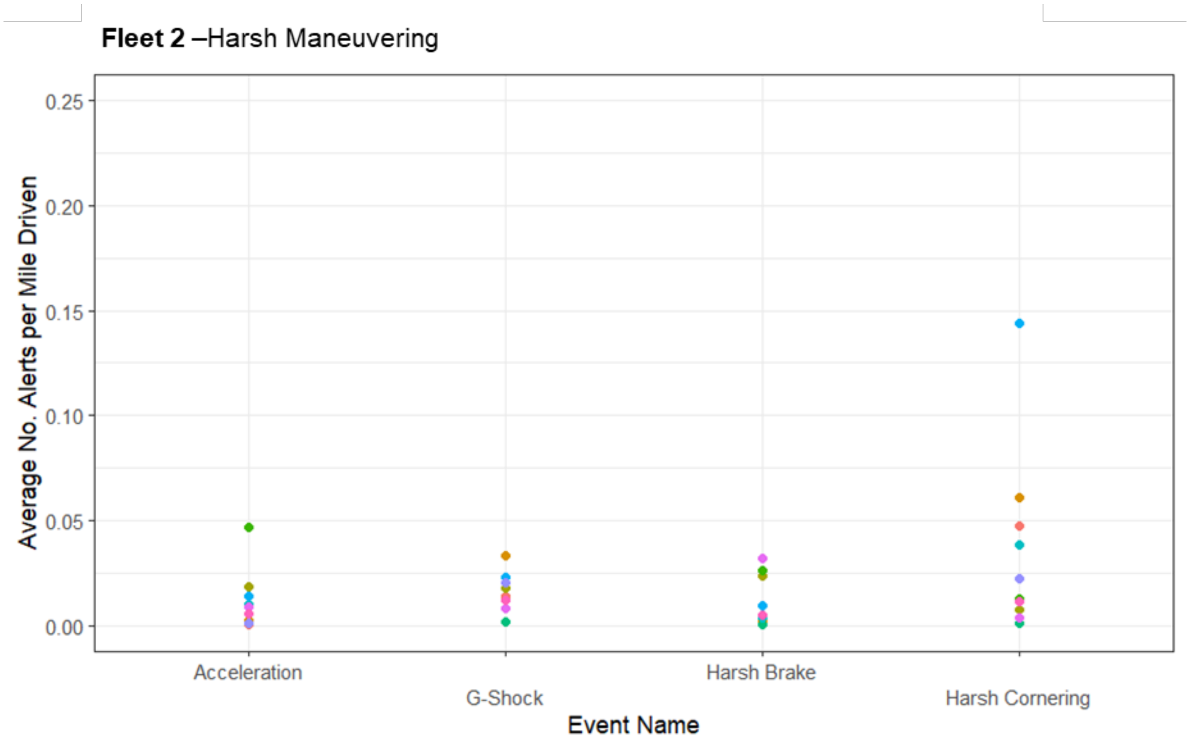

Figure 20. Fleet 2 harsh maneuvering

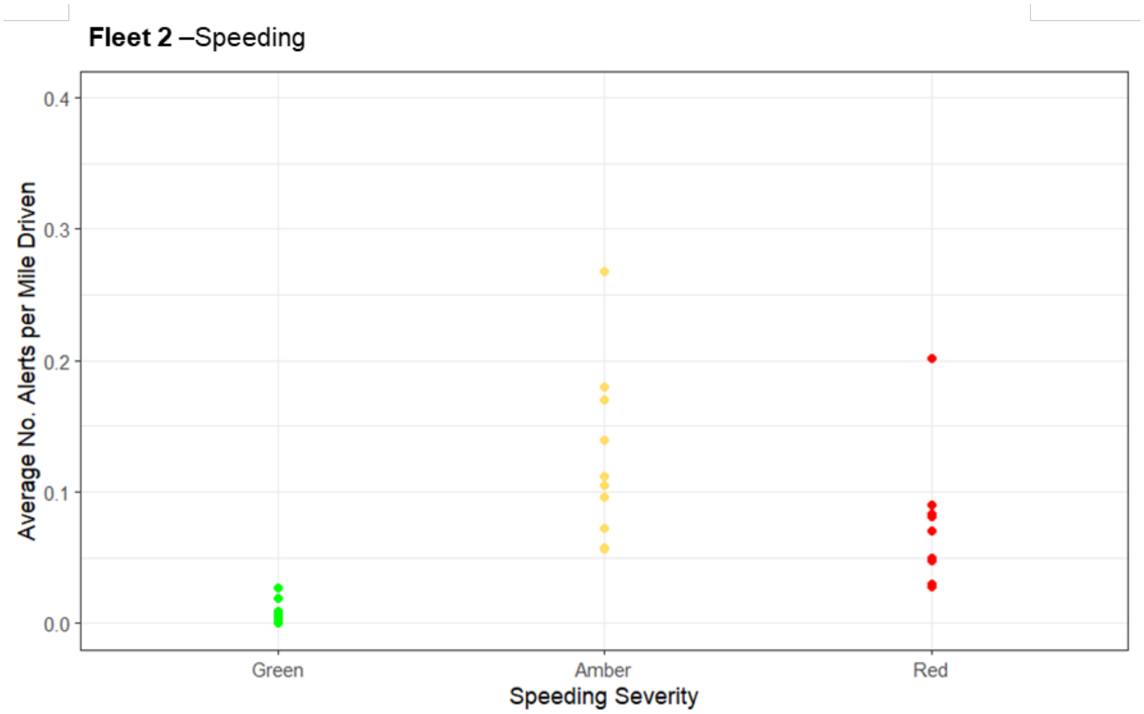

Figure 21. Fleet 2 Speeding alerts

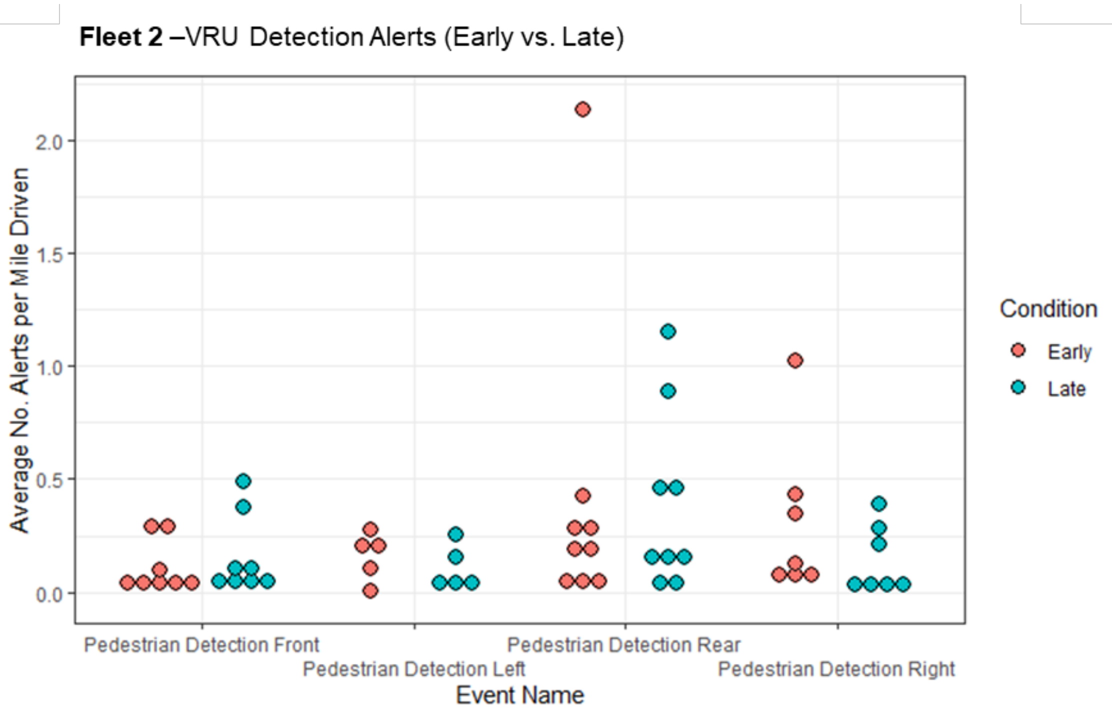

Figure 22. Fleet 2 VRU alerts

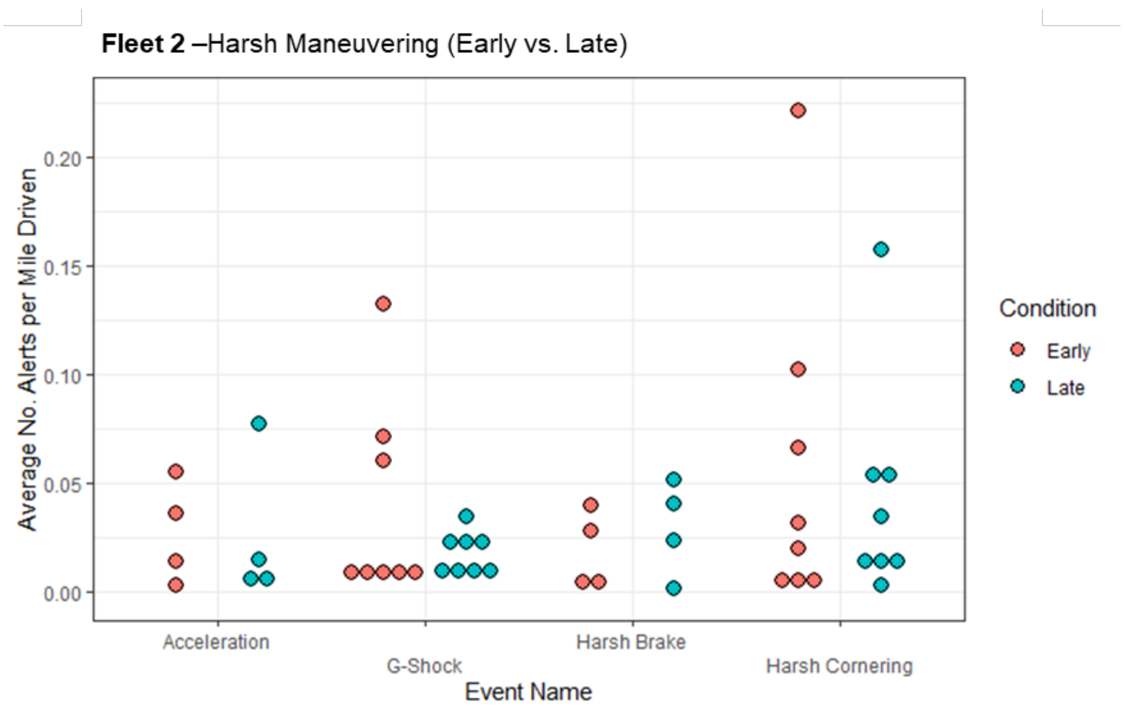

Figure 23. Fleet 2 harsh maneuvering

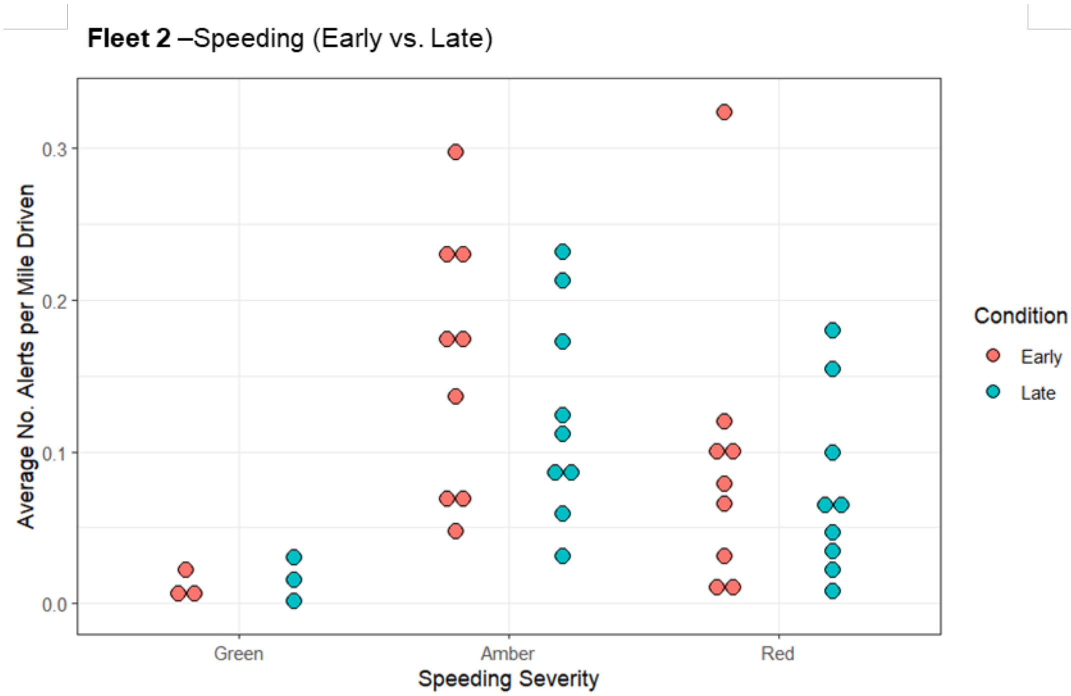

Figure 24. Fleet 2 speeding alerts

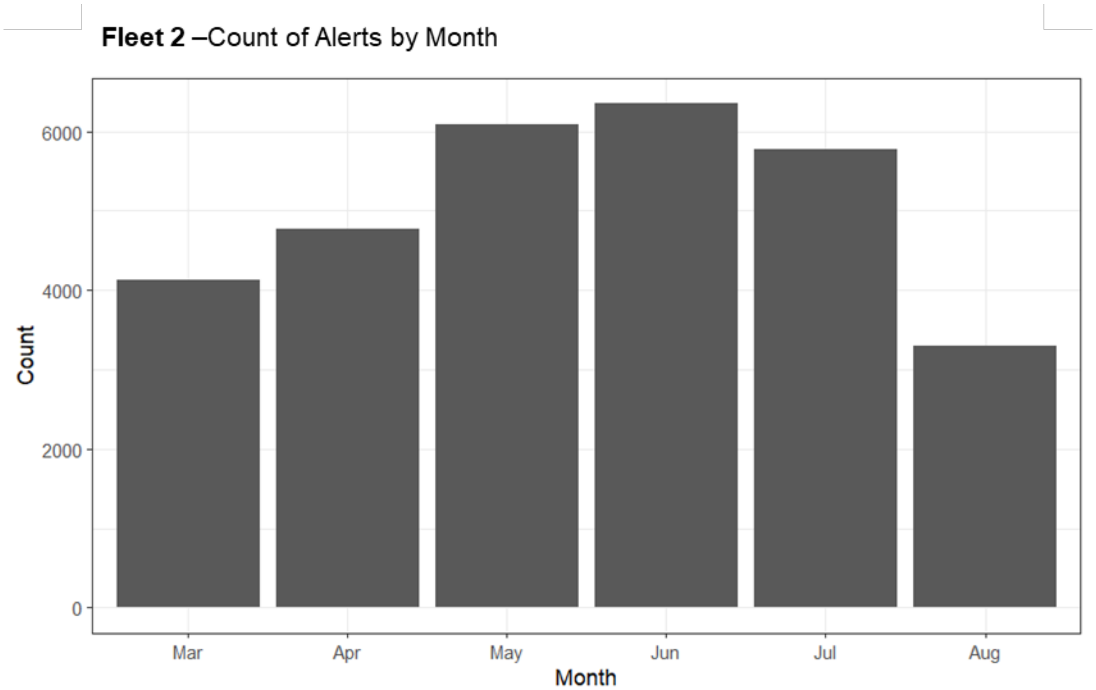

Figure 25. Fleet 2 count VRU alerts by month

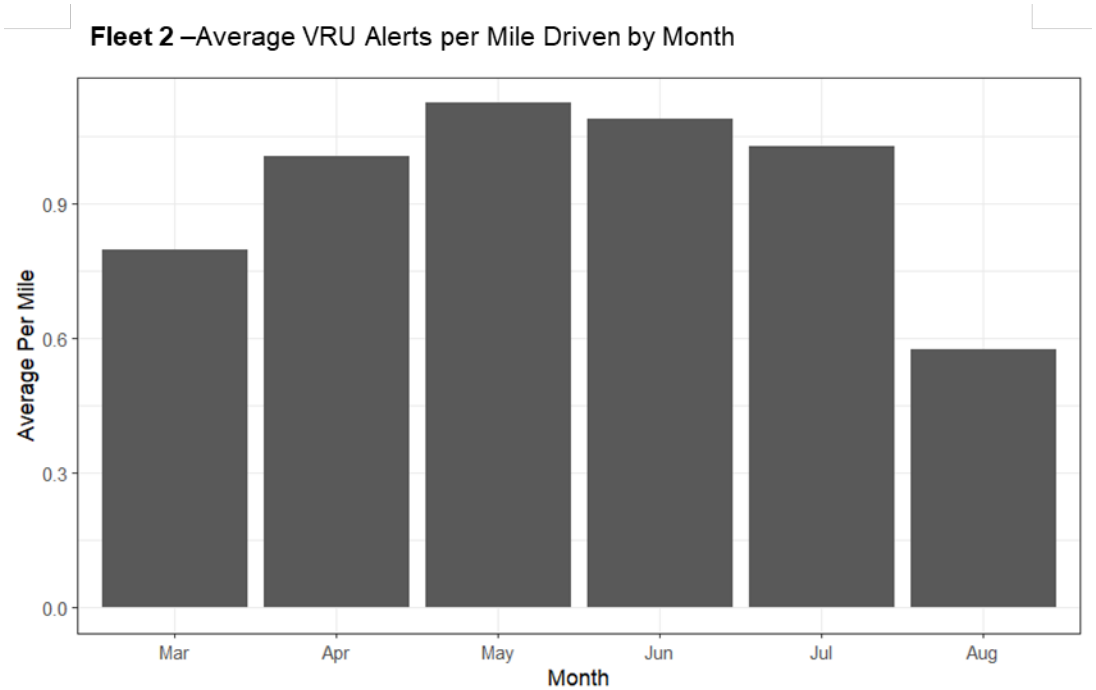

Figure 26. Fleet 2 VRU alerts by month per mile driven

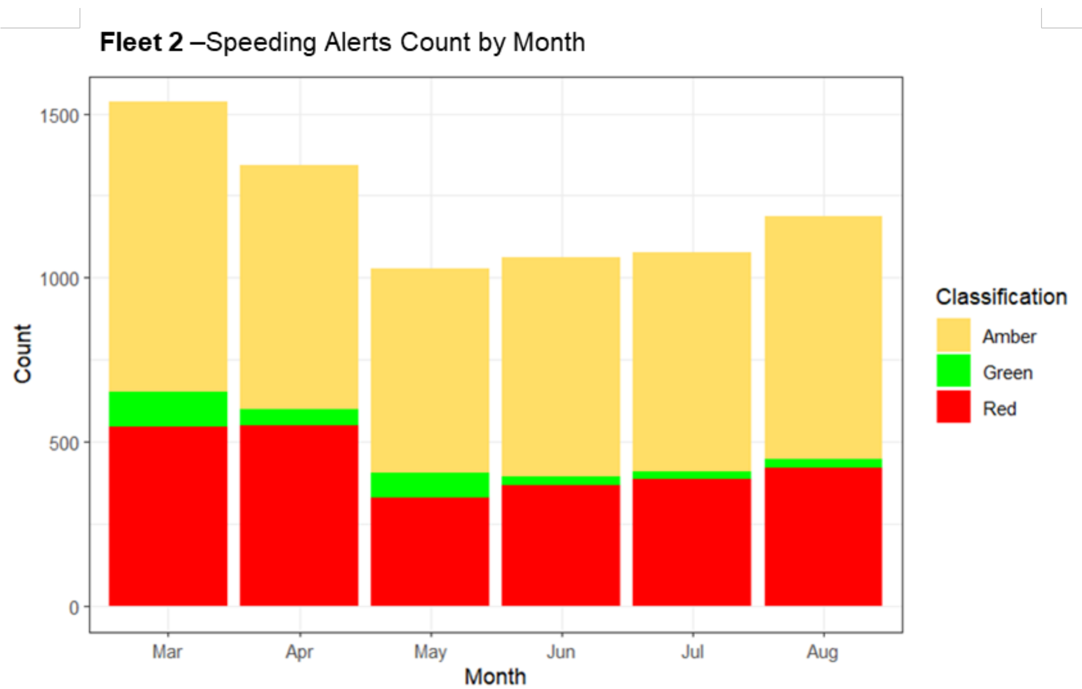

Figure 27. Fleet 2 speeding alerts by month

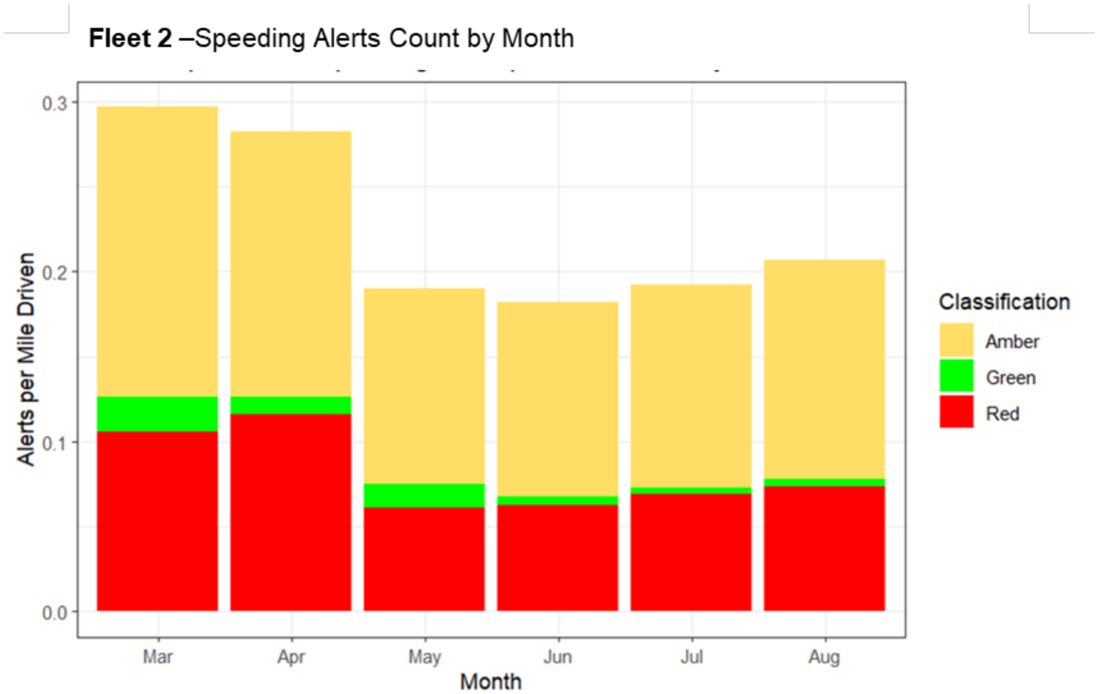

Figure 28. Fleet 2 speeding alerts by month per mile driven

6.4 AB InBev

Figure 29. AB InBev VRU alerts

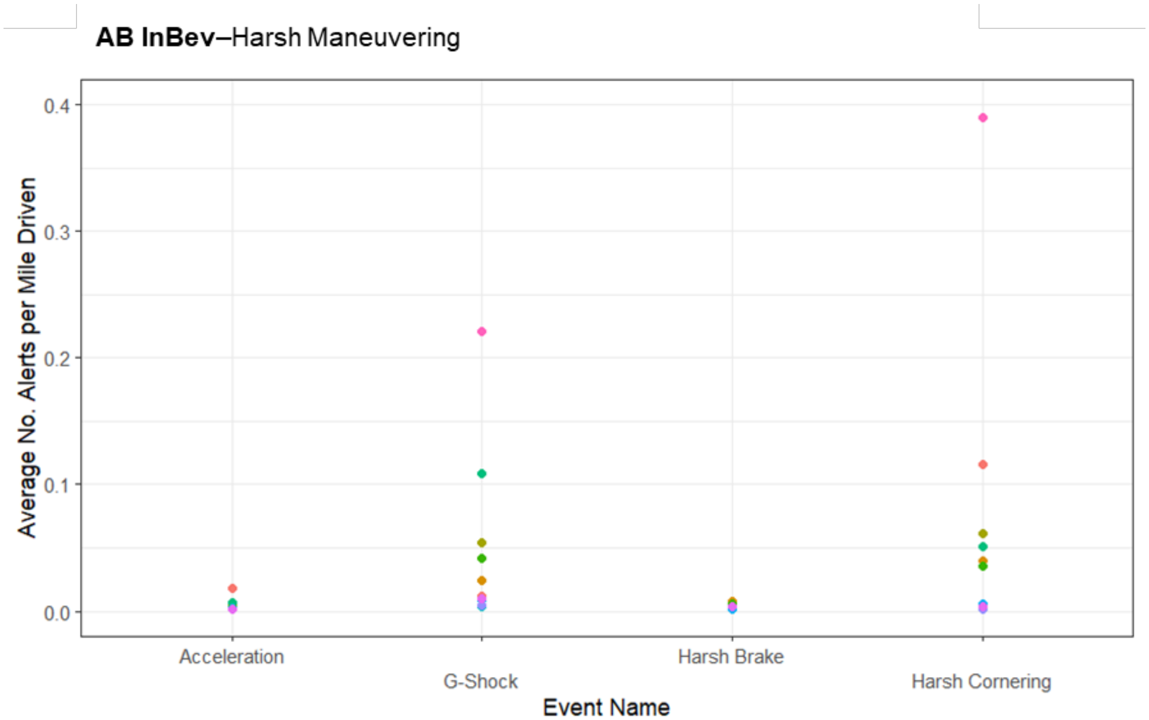

Figure 30. AB InBev harsh maneuvering alerts

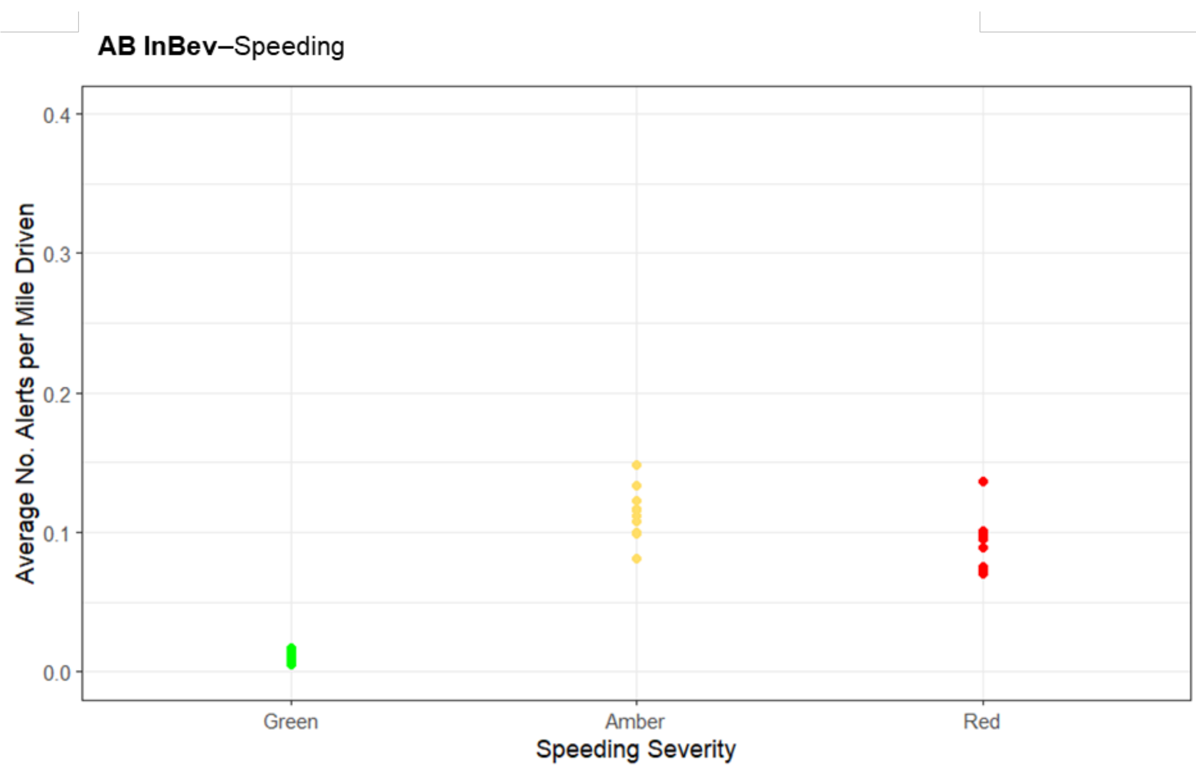

Figure 31. AB InBev speeding alerts

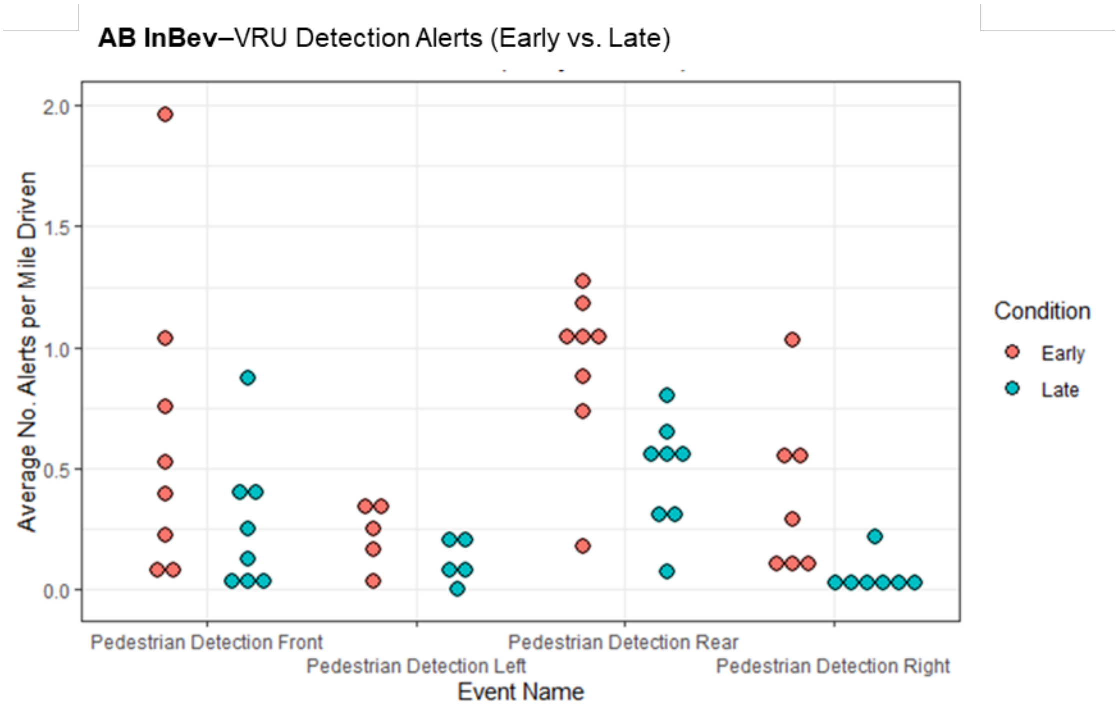

Figure 32. AB InBev VRU alerts

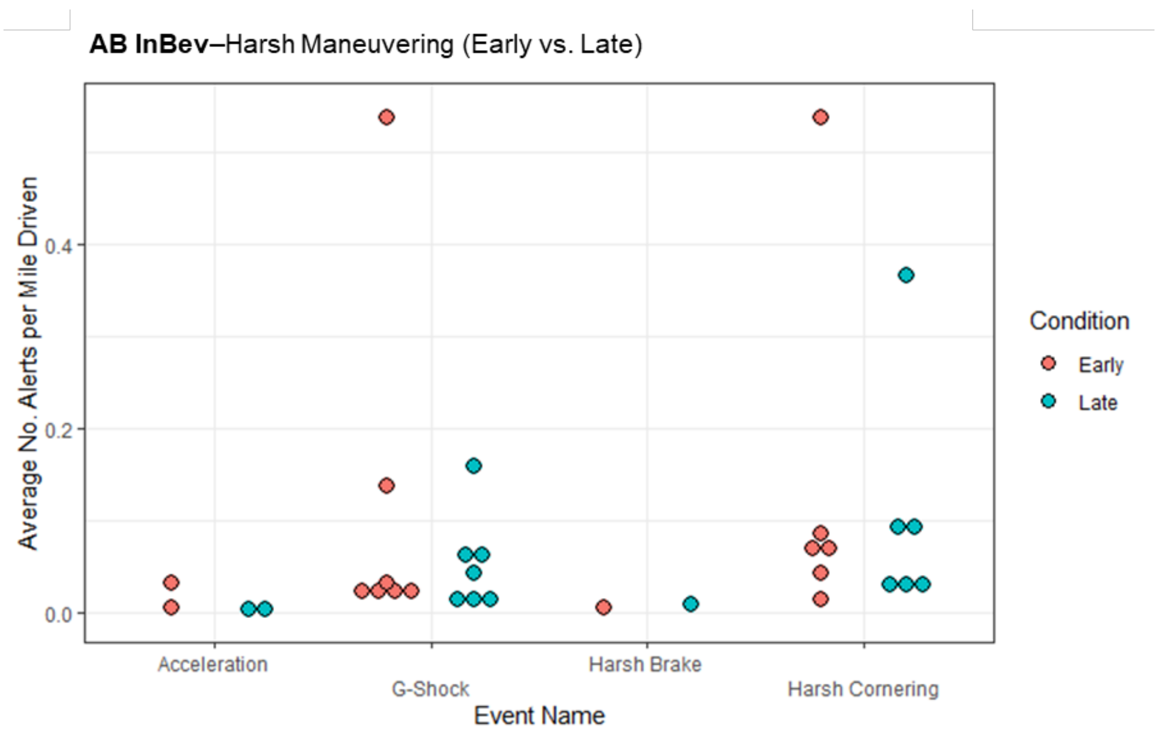

Figure 33. AB InBev harsh maneuvering alerts

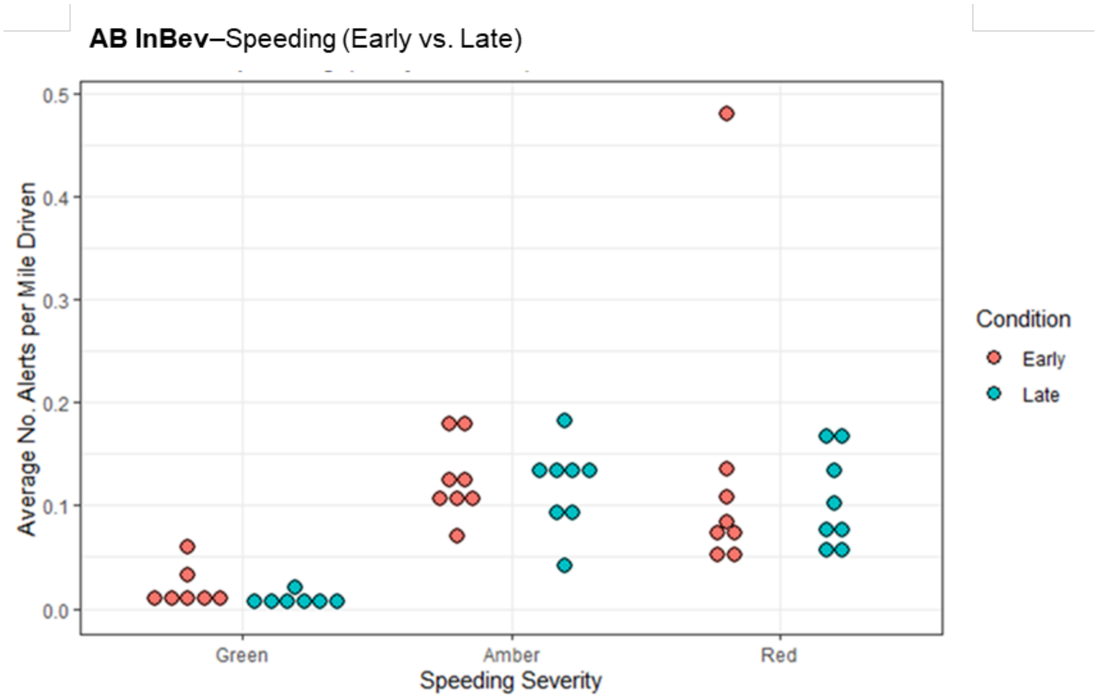

Figure 34. AB InBev speeding alerts

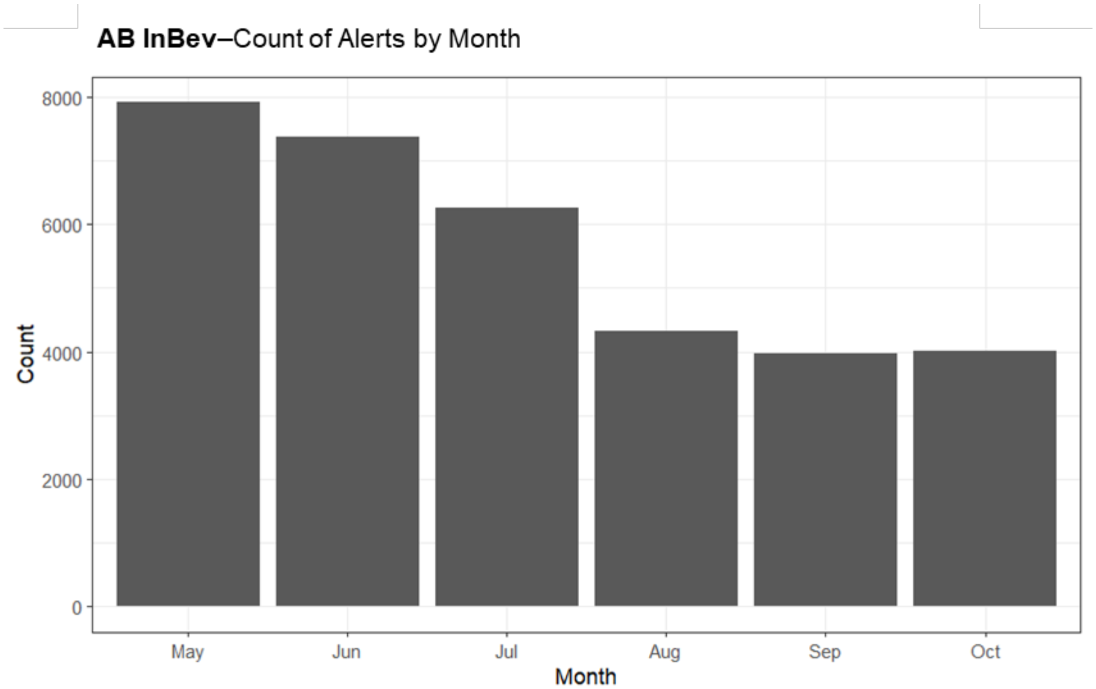

Figure 35. AB InBev VRU alert count by month

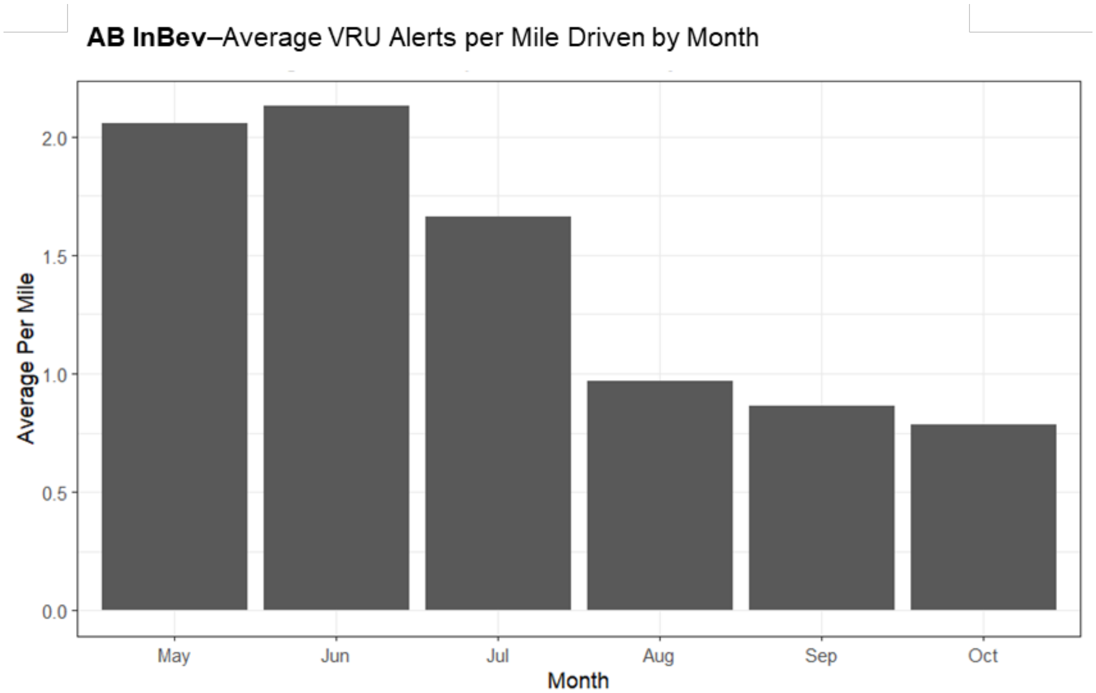

Figure 36. AB InBev VRU alerts by month per mile driven

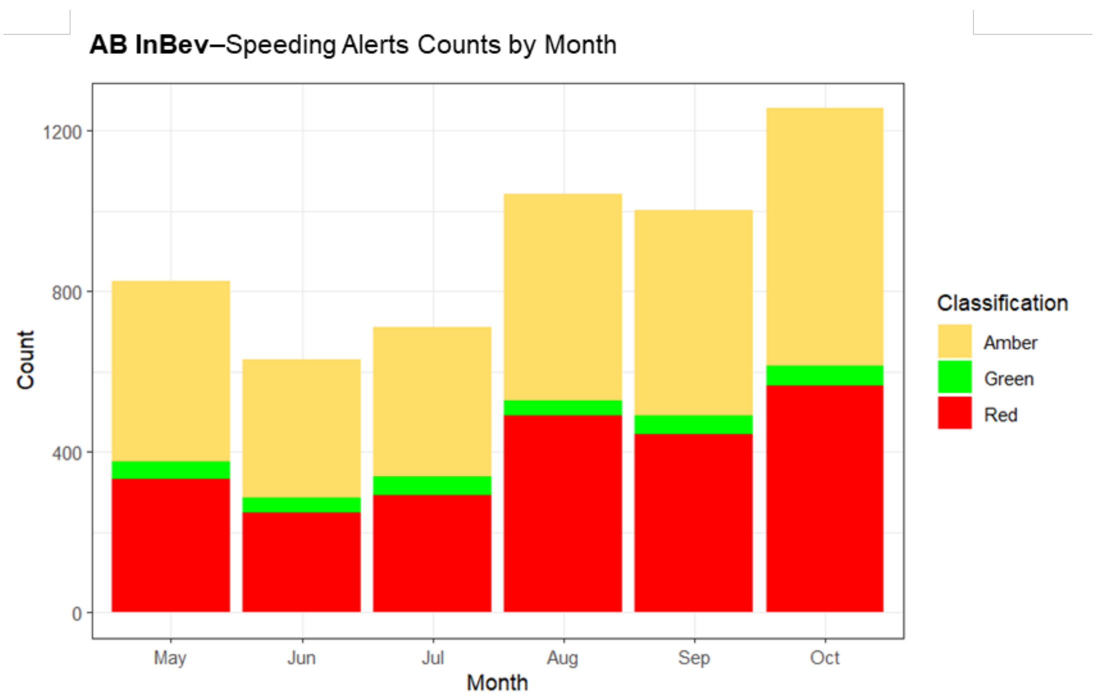

Figure 37. AB InBev speeding alerts count by month

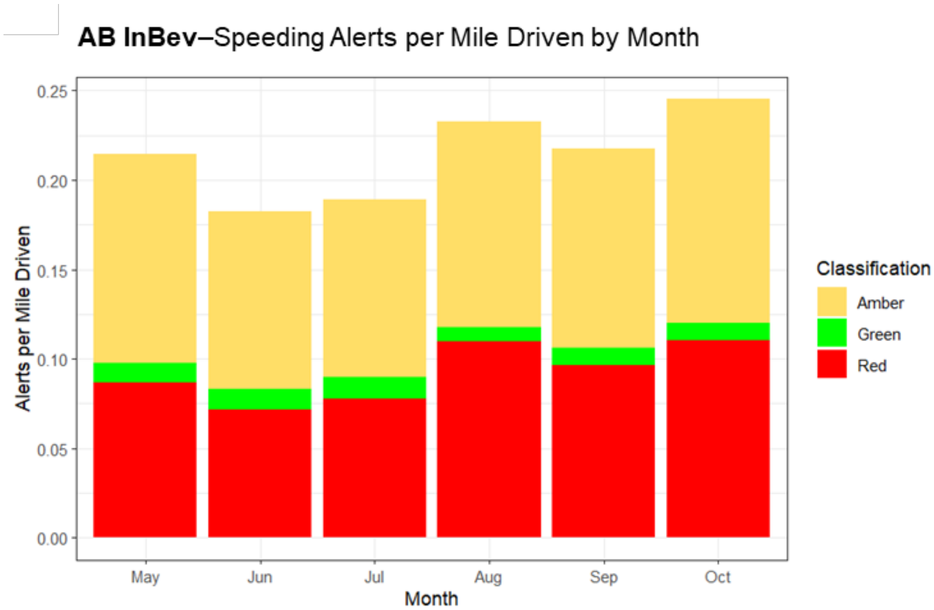

Figure 38. AB InBev speeding alerts by month per mile driven

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